APPENDIX A
TO CONSENT DECREE

Work Plan for Operable Unit 1
California Gulch Superfund Site
Leadville, Colorado
May 2008

Project No. 180885/37

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LIST OF ACRONYMS

Ag	silver
Al	aluminum
amsl	above mean sea level
As	arsenic
AS or Acid Sol.	acid soluble
BIL	blockage influent line
$CaCO_3$	calcium carbonate
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain-of-custody
CONT	continuous
CP	Contingency Plan
Cr	Chromium
Cu	copper
DMR	discharge monitoring report
EPA	United States Environmental Protection Agency
Fe	iron
GIL	gravity-influent line
gpm	gallons per minute
HDPE	High Density Polyethylene
Hg	Mercury
HMI	human machine interface
kg/day	kilograms day
lbs	pounds
lbs/day	pounds per day
MDL	Method Detection Limit
MGD	million gallons per day
mg/L	milligrams per liter
mg eq.	milligram equivalent
Mn	Manganese

O&M	Operation and Maintenance
OU1	Operable Unit 1 of the California Gulch Superfund Site
Pb	Lead
PLC	process logic controller
PQL	Practical Quantitation Limit
PVC	poly-vinyl chloride
QA	Quality assurance
QC	Quality control
%R	percent recovery
RMP	Routine Monitoring Plan
ROD	Record of Decision
RPD	relative percent difference
SAP	Sampling and Analysis Plan
Se	Selenium
SPIL	surge pond influent line
SOP	Standard Operating Procedure
State	State of Colorado
s.u.	standard units
T	Total
TCLP	Toxicity Characteristic Leaching Procedure
TR or TOTAL REC	total recoverable
TSS	total suspended solids
UAO	Unilateral Administrative Order
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
VFD	variable frequency drive
WET	Whole Effluent Toxicity
WTP	Yak Tunnel Water Treatment Plant
Zn	Zinc

1.0 PURPOSE

The purpose of this plan is to provide a single document that presents and describes the completed remedial action work and controls that have been implemented to address the selected remedy for Operable Unit 1 of the California Gulch Superfund Site (OU1), and provide procedures for performance of operations and maintenance (O&M) of the OU1 remedy. This plan further sets forth the procedures for addressing future changes in hydrologic conditions within the Yak Tunnel Hydrologic System. This plan shall be implemented in accordance with the Consent Decree by and among the United States, State of Colorado, Newmont USA Limited, and Resurrection Mining Company, to which this Work Plan is appended.

OU1 remedies are described in Section 4.0 and include the following:

1) Influent Raw Water Sources and Support Systems
2) Influent Pre-Treatment System
3) Primary Treatment Process
4) Effluent System

The Routine Monitoring Plan (RMP) (MFG, 2008a) and Contingency Plan (CP) (MFG, 2008b), which are appended to and incorporated into this plan, provide further details governing routine monitoring, planning, and decision-making. The RMP and CP are generally discussed in Section 10.0.

The O&M manuals, listed in Section 6.0, are incorporated into this plan. The O&M manuals provide further details on the operation and maintenance of the OU1 remedy.

2.0 HISTORY

The California Gulch site, which includes OU1, was placed on the National Priorities List (NPL) in 1983. Since that time, a number of actions have been taken to control releases and protect human health and the environment. Some of the more important documents regarding the response actions at OU1 include the following:

1) Phase I Remedial Investigation Report, Feasibility Study Report, Proposed Remedial Action Plan (CH2M Hill, 1987a; CH2M Hill, 1987b; EPA, 1987)
2) The Record of Decision (ROD) (EPA, 1988a)
3) Administrative Order for Surge Pond and Interim Treatment Facility (EPA, 1988b)
4) Modification to the ROD (EPA, 1989a)
5) Unilateral Administrative Order (UAO) (EPA, 1989b)
6) Explanation of Significant Differences (EPA, 1991b)
7) First and second amendments to the UAO (EPA, 1993a; EPA, 1993b)
8) Final Sampling and Analysis Plan (SAP) (Baker, 1993)
9) Draft Final Yak Tunnel Water Treatment Plant Discharge Control Mechanism and Statement of Basis – Redline Version (Res-ASARCO, 1994)
10) Routine Monitoring Plan (Revision 1) (MFG, 1999a)
11) Contingency Plan, Revision 1 (MFG, 1999b)
12) Enhanced Monitoring Program (ASARCO, 2002)
13) EPA Letter reducing WTP Yak Water Treatment Plant sampling from weekly to monthly and Whole Effluent Toxicity testing to semi-annually (EPA, 2002)
14) Additional Investigation Work Plan (MFG, 2004)

Based on the ROD, UAO, and other governing documents, the facilities described below were constructed and placed into operation.

Construction of the surge pond and interim treatment facility were completed in 1989. The surge pond was constructed to collect water from the Yak Tunnel as well as surface water from the site area and to equalize flows for the treatment plant. The interim treatment facility consisted of a four cell, multi-media filter designed to remove suspended solids after lime addition prior to discharge of water to California Gulch. The filter building still exists next to the surge pond, and is used for storage and electrical system distribution, but the filters have been removed.

The Yak Tunnel Water Treatment Plant (WTP) was constructed and placed into operation in 1992. The WTP was constructed to treat water from the Yak Tunnel and surface water from the site. Currently, the treatment plant also treats Yak Tunnel blockage water pumped from the Black Cloud Mine and water collected at Oregon Gulch (OU10). Ancillary facilities associated with the WTP include untreated and treated water conveyances, a potable water pump station, and a fire-flow pump station, which are described in Section 4.0.

The Yak Tunnel bulkhead was constructed and placed into operation in 1994. The bulkhead was constructed to prevent surges to California Gulch and to equalize and control flows to the WTP.

The Yak Tunnel blockage pumps were installed in the Black Cloud mine shaft to draw down water levels that were increasing behind the blockage, and a conveyance pipeline from the pumps to the WTP was completed in 2005. Operation of the Yak Tunnel blockage pumps began in March of 2006.

3.0 DEFINITIONS

Unless otherwise defined below, terms used in this Work Plan shall have the meaning assigned to them in CERCLA or the National Contingency Plan. Whenever any of the terms listed below are used in this Work Plan, the following definitions shall apply:

The "7-day (and weekly) average" is the arithmetic average of all samples collected during a consecutive 7-day period or calendar week, whichever is applicable. The 7-day and weekly averages are applicable only to those effluent characteristics for which there are 7-day average effluent limitations. The calendar week, which begins on Sunday and ends on Saturday, shall be used for purposes of reporting monitoring data on discharge monitoring report forms. Weekly averages shall be calculated for all calendar weeks with Saturdays in the month. If a calendar week overlaps two months (i.e., the Sunday is in one month and the Saturday in the following month), the weekly average calculated for that calendar week shall be included in the data for the month that contains the Saturday.

The "30-day (and monthly) average" is the arithmetic average of all samples collected during a consecutive 30-day period or calendar month, whichever is applicable. The calendar month shall be used for purposes of reporting monitoring data on discharge monitoring report forms.

"Acid Soluble Aluminum" means that portion of aluminum in a sample which will pass through a 0.45 micron membrane filter following acidification to pH 1.5-2.0 with ultrapure nitric acid.

"Acute Toxicity" as it applies to whole effluent toxicity (WET) testing, is indicated when 50 percent or more mortality is observed for either Ceriodaphnia or fathead minnow species at any effluent concentrations. Mortality in the control must be 10 percent or less for the effluent results to be considered valid.

"Bypass" means the intentional diversion of influent or Waste Streams from any portion of the WTP. Bypass does not include flows or discharges that are authorized under Section 7.1 below.

"Composite samples" shall be flow proportioned. The composite sample shall, at a minimum, contain at least four (4) samples collected over the compositing period. Unless otherwise specified, the time between the collection of the first sample and the last sample shall not be less than six (6) hours or more than 24 hours. Acceptable methods for preparation of composite samples are as follows:

- Constant time interval between samples, sample volume proportional to flow rate at time of sampling.

- Constant time interval between samples, sample volume proportional to total flow (volume) since last sample. For the first sample, the flow rate at the time the sample was collected may be used.
- Constant sample volume, time interval between samples proportional to flow (i.e. sample taken every “X” gallons of flow).
- Continuous collection of sample, with sample collection rate proportional to flow rate.

“Daily Maximum” (“Daily Max”) is the maximum constituent value determined by any single sample or instantaneous measurement.

A “grab” sample, for monitoring requirements, is defined as a single “dip and take” sample collected at a representative point in the discharge stream.

The term “influent” means a source of non-potable and untreated water that flows, or is pumped, to the Yak Tunnel Water Treatment Plant.

An “instantaneous” measurement, for monitoring requirements, is defined as a single reading, observation, or measurement.

“Total Metals” or “Total Recoverable Metals” means that portion of a water and suspended sediment sample measured by the total or total recoverable analytical procedure described in “Methods for Chemical Analysis of Water and Wastes,” U.S. Environmental Protection Agency, most recent version, or its equivalent.

“Quality assurance” (QA) is defined as the integrated program designed for assuring reliability of monitoring and measurement data.

“Quality control” (QC) is defined as the routine application of procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

“State” means the State of Colorado Department of Public Health and the Environment, and any successor agency.

“Upset” means an exceptional incident in which there is unintentional and temporary noncompliance with the effluent limitations because of factors beyond the reasonable control of the operator. An Upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, lack of preventative maintenance, or careless or improper operation.

“Waste Stream” means waste derived from the treatment process in the treatment facility that exceeds effluent limitations.

“Yak Tunnel Conveyance System” means a series of ditches and pipelines used to convey water from the Yak Tunnel Portal, behind the Yak Tunnel blockage, Hillside seep and surge pond to the WTP as described in Sections 4.1.2, 4.1.3, 4.1.4 and 4.1.5 and any future influent sources from the Yak Tunnel Hydrologic System.

“Yak Tunnel Hydrologic System” means the subsurface flow system that consists of the entire length of the Yak Tunnel and groundwater which flows to or from the Yak Tunnel.

4.0 REMEDIAL ACTION COMPONENTS

The WTP treats water from several sources before discharging the treated water to California Gulch. The plant removes metals from the influent water through a combination of oxidization, pH adjustment, and flocculation. The plant and associated processes are run by a process logic controller (PLC) and a human machine interface (HMI). The HMI allows an operator to change process, flows, etc. in the plant without having to change the programming in the PLC. The HMI allows monitoring of the various processes in the plant and ancillary facilities and will send out an alarm if the processes deviate from set standards. The following subsections describe the various influent sources, WTP facilities, support facilities and the processes that comprise the treatment system.

The water treatment facility is primarily composed of the following components:

- Influent raw water sources and support systems
- Influent pre-treatment system
- Primary treatment process
- Effluent system

Figure 1 presents a simplified diagram of the WTP facility components and treatment process. The following sections describe these components in detail.

4.1 Influent Raw Water Sources and Support Systems

The WTP influent sources include water from the Yak Tunnel bulkhead, WTP surge pond, Yak Tunnel blockage pumps currently located in the Black Cloud shaft, OU-10 Oregon Gulch seepage collection system, and the Hillside spring. The raw water from these sources is brought to the WTP by the Yak Tunnel Conveyance System and the Oregon Gulch seep conveyance system. In addition, other water pipelines and support systems are required to either provide potable water, or facility protection, or to transmit WTP effluent to California Gulch. Each of these sources and systems are discussed below.

4.1.1 Yak Tunnel Bulkhead

The Yak Tunnel was constructed as a drain for mines in the area. Approximately 1,678 feet upgradient from the Yak Tunnel Portal, the Yak Tunnel Bulkhead was constructed to control flow from the tunnel. The bulkhead was designed to manage Yak Tunnel mine water so that surges and other rapid increases or decreases in flow within the tunnel can be controlled. The bulkhead is an engineered dam within the Yak Tunnel and allows for the passage of controlled flow rates through the bulkhead down to the WTP. The bulkhead is fitted with three pipe outlets, one of which serves as the actual outlet for the transfer of water from behind the bulkhead, the second and third of which are spares or backup outlet pipes. Under baseline flow conditions, the bulkhead is designed to allow sediment settling and water staging within the tunnel. Sediment deposition is controlled by the bulkhead design and the outlet pipe placement 12 inches off the tunnel floor. Sediment deposition below this 12-inch level does not interfere with flow through the lower two outlet pipe(s) and is considered acceptable. The third outlet pipe is 32 inches above the tunnel floor and is used as an emergency overflow should the lower pipes become plugged. Figures 2 and 3 show the bulkhead design and flow through pipes, respectively.

Yak Tunnel mine water flows through one of two pipes installed in the bulkhead and flow rates are controlled by the operation of the manual and electric flow control valves. The electric flow control valve may be either manually controlled or controlled from the treatment plant HMI. During a power failure, the electric flow control valve will automatically close and water will collect behind the bulkhead. Water elevations behind the bulkhead are monitored and reported by a pressure transducer and transmitter installed at the bulkhead.

If the water elevation behind the bulkhead rises above the set point, as measured by the pressure transducer, an alarm will be sent by the HMI system to the operators.

Water transmitted through the flow control valves flows from the bulkhead through a 12-inch High Density Polyethylene (HDPE) pipeline to the tunnel portal and is then transferred into an open rip-rapped lined channel which conveys the water from the bulkhead to the WTP diverter box, as described in Section 4.1.2. To prevent unauthorized access, the Yak Tunnel Portal is secured with a closed, locked steel gate.

The major components of the Yak Tunnel Bulkhead System include:

- Yak Tunnel
- Upstream steel debris grizzly
- Bulkhead
- Flow through pipes (2)
- Manual and electric control valves
- Compressed air line (through the bulkhead)
- Milltronics Micro Ranger II (Pressure Transducer)
- Rosemount pressure transmitter
- Manway through the bulkhead
- Ventilation fan
- 12 inch HDPE Pipeline

All bulkhead control and monitoring parameters are integrated into the WTP control system, allowing the existing alarm and callout systems to be utilized.

4.1.1.1 Bulkhead Water Quantity and Quality

Typically, infiltration and flows into the Yak Tunnel increase in the late spring and decrease in early to mid summer. The bulkhead water level should be at or near its allowed low point (20 ft) in late April to early May in order to provide capacity for storage of snow melt. This will allow more retention time for managing higher flows to the Yak Tunnel during the spring. The water level behind and related flows through the bulkhead can be controlled by opening and closing the automatic or manual valves.

Seasonal flows from the Yak Tunnel will vary depending on snow pack and precipitation. In 2007, the flow rates from the Yak Tunnel ranged from a maximum of approximately 700 gpm in early June to shutting the valves and stopping flow in the winter. In 2006, the flow rates from the Yak Tunnel ranged from a maximum of approximately 600 gpm in mid May to less than 65 gpm in the winter. Generally, Yak Tunnel influent pH ranges from 5.5 to 6.5 s.u. with specific electrical conductivity ranging from 1400 to 1600 microsiemens per centimeter (µS/cm) and zinc concentrations ranging from 65 to 110 mg/l.

4.1.2 Conveyance of Yak Tunnel Water

As shown on Figure 4, the Yak Tunnel Conveyance System currently includes a series of ditches and pipelines used to convey water from the Yak Tunnel Portal to the WTP or surge pond. Water that accumulates within the tunnel between the portal and the bulkhead is collected along the tunnel floor and flows from the portal entrance through a 30-foot long open rip-rap swale into a 16-foot by 10-foot by 15-foot deep reinforced concrete collection sump located on the north side of California Gulch. The collection sump intake is screened with an expanded steel grate to preclude transfer of deleterious debris (i.e., twigs, branches, etc.). A 24-inch diameter HDPE outflow pipe conveys water a distance of 120 feet from the collection sump, under the California Gulch Channel, to an open rip-rap lined conveyance channel located on the south side of California Gulch. The 24-inch HDPE outflow pipe is located halfway up the south wall of the sump and is connected to the sump with a 25-inch diameter sleeve. Flow from the bulkhead pipeline is piped under the California Gulch Channel to the same open rip-rap lined conveyance channel. The conveyance channel carries the water approximately 900 feet from the 12-inch bulkhead pipeline outflow and 24-inch HDPE pipeline outflow to a pre-cast concrete drop inlet structure called the diverter box.

Water from the diverter box can be either transferred to the WTP or the surge pond. The diverter box is sized to allow settling of coarse particles from the influent feed. Trash screens are also provided to prevent large debris from entering the water treatment plant. Periodically, the debris and trash must be manually removed from the diverter box. A manual valve installed in the diverter box prevents flow to the plant, if necessary. Overflow from the diverter box flows to the surge pond.

A gravity flow 10-inch HDPE pipeline (gravity-influent line [GIL]) is installed above ground from the diverter box to the WTP. The GIL pipeline has a minimum slope of one percent to the WTP. In order to monitor influent flows to the WTP, a flow meter is installed on the 10-inch pipeline after it enters the WTP. The gravity flow pipe to the WTP is free draining to the WTP, should flow be diverted to the surge pond from the WTP. However, during winter months the pipeline is blown out with compressed air to ensure the pipe does not freeze.

Water flows from the diverter box to the surge pond via a buried 6-inch poly-vinyl chloride (PVC) pipeline, for a distance of approximately 2,400 feet. The 6-inch PVC pipe at the surge pond is located below the grouted rip-rap splash pad, and outflow from the pipeline is emitted below the water surface.

An emergency overflow rip-rap and grouted rip-rap lined channel is constructed downstream of the diverter box structure to carry flows greater than the capacity of the 6-inch pipeline to the surge pond. A grouted rip-rap berm constructed just downstream of the drop inlet separates the emergency overflow channel from the drop inlet structure and prevents normal flows from passing down the emergency overflow channel. In the event that the capacity of the drop inlet structure is exceeded, excess flow will pass over the separating berm, down the emergency overflow channel, through an 18-inch HDPE overflow pipeline and to the surge pond. The 18-inch diameter HDPE overflow pipeline is connected to a 24-inch diameter PVC pipe approximately halfway between the pipe inlet and the surge pond by a sealed annulus, and this joint is encased in concrete. The 24-inch pipe discharges onto a grouted rip-rap splash pad at the east end of the surge pond above the 6-inch diameter inflow line.

A natural spring is located at the base of the hillside south of the emergency Overflow Ditch. A hillside spring collection structure collects seasonal flows from the spring and drains into a 6-inch diameter HDPE drain pipeline. The drain pipeline crosses under the emergency overflow channel and parallels the access road. Approximately 900 feet downstream of the collection structure, the 6-inch pipeline drains into the lower end of the emergency overflow channel, at the grouted rip-rap inlet basin for the 18-inch HDPE pipeline and is then transported to the surge pond. The flow from the spring is generally seasonal, with flow starting during spring runoff and subsiding by July.

The major components of the Yak Tunnel Conveyance System are listed in order from the Yak Tunnel Portal to the WTP and surge pond:

- Yak Portal and portal gate
- Portal swale
- Reinforced concrete sump with intake grate
- 24-inch diameter HDPE drain pipeline
- Open conveyance channel
- Drop inlet structure (Diverter box)
- 10-inch diameter HDPE GIL pipeline – WTP
- 6-inch diameter PVC flow pipeline – surge pond
- Emergency Overflow Channel (rip-rap and grouted rip-rap lined) – surge pond
- 18- and 24-inch diameter HDPE pipeline – surge pond
- 24-inch HDPE pipeline splash pad – surge pond
- Hillside spring collection structure and 6-inch diameter pipeline drain – Surge Pond

Diversion channels have been constructed in California Gulch to collect storm and surface water runoff from the California Gulch watershed and route these waters around the WTP and surge pond. The system is composed of three separate water conveyance structures: the California Gulch diversion channel, South Slope interceptor channel, and South channel. The California Gulch diversion channel is designed to collect water entering the drainage, upstream from California Gulch, and divert this water around the surge pond. The diversion channel is designed for peak flows from a 500-year storm event. The South Slope interceptor channel is located at the base of the south slope adjacent to the emergency overflow channel. Precipitation on the south slope drains into the south slope interceptor channel and is then carried to the California Gulch diversion channel. South channel is located south of the surge pond and provides drainage for precipitation that occurs in this 25-acre area. Flow enters South channel from surface and storm water runoff and constructed side inflow channels. Flow from South channel enters California Gulch diversion channel downstream of the toe of the surge pond buttress.

4.1.3 Surge Pond

As part of the selected remedy, a 20 million gallon capacity, 7.5 acre surge pond was constructed during the 1989 field season at a location approximately one-half mile down valley from the Yak Portal. The pond was designed to collect influent water from the Yak Tunnel and to remove much of the suspended sediment load by sedimentation with supplemental filtration provided by a small filtration plant located adjacent to the pond. After the Yak WTP went into operation, the supplemental filter system was removed from the filtration plant. The surge pond is built on a surface of reworked mill tailing. The downstream face of the existing tailing embankment was buttressed with mine waste rock and the pond surface was surrounded by a berm of mine waste rock. A channel was constructed at the bottom of the surge pond to divert water in the pond toward the location of the barge mounted pumps. The surge pond bottom and berm are lined with an HDPE geomembrane. Prior to installation of the liner, the inside slopes of the berm were covered with a bedding layer of tailing. The bottom of the new pond was lined with a 60 mil HDPE geomembrane, and the inside slopes of the berm were covered with an 80 mil geomembrane. The liner is overlain on the side slopes with geofabric, sand, and a protective layer and bench of mine waste rock.

A floating barge pump system is located in the southwest corner of the surge pond. The purpose of the barge transfer system is to convey water from the surge pond to the WTP. Either a 500 gpm horizontal, centrifugal pump or a 75 gpm submersible pump can be used to transfer water to the WTP depending on the level of the surge pond, influent water chemistry, and WTP capacity. As shown on Figure 5, surge pond water is pumped from the surge pond to the WTP via a single pipeline when above ground, and a double-contained pipeline where buried. The piping from the pond to the plant is composed of SDR 13.5 HDPE. A flow meter is installed in the pipeline after the pipeline enters the WTP. The carrier pipe is 8-inch in diameter and the containment pipe is 12-inch in diameter where buried. A head frame is located over the pump barge on which an overhead crane is mounted and is used to allow pump maintenance and removal. The barge is attached to a steel walkway supported by steel pontoons. It provides access to the pumps and houses the pipe used for transferring water from the pumps to the WTP. The walkway is anchored near the filter building, and cable stays anchored on either side of the filter building provide stability for the walkway and barge. An aeration system is mounted to the pump barge. The aeration system is operated during the winter months and is used to prevent the formation of ice around the pump barge. In addition, surge pond pumps are re-circulated during winter months to prevent freeze.

An emergency spillway is located at the northwest corner of the surge pond. If the storage capacity of the pond is exceeded, water will overflow through the spillway into the California Gulch Diversion Channel.

A staff gauge is located near the pump barge to record water levels in the pond. Surface monuments are located along the west and north berm to monitor movements. The pond perimeter is enclosed by a 6-foot high chain-link security fence.

Major components of the surge pond are listed below:

- HDPE geomembrane liner system

- Protective geotextile fabric
- Protective sand cover
- Protective mine waste rock cover
- Surface monuments
- Fiberglass staff gauge
- 6-and 24-inch inflow pipelines and splash pads
- Filter backwash pipeline
- Emergency spillway
- Surge pond berm
- Access road
- Pump barge
- Security fence and access gate
- Buttress for existing tailing embankment

The major components of the barge transfer system are:

- One 500 gpm vertical pump and one 75 gpm submersible pump
- Steel pump barge and pontoons
- Steel walkway and pontoons
- 8-inch HDPE influent conveyance pipe
- Pump selector switches and switch gear
- Overhead crane

4.1.3.1 Surge Pond Water Quantity and Quality

Typically, flows into the surge pond increase in May and decrease in late June. The primary sources of water to the surge pond during May and June consist of the Hillside spring and surface runoff from melting snow. The surge pond water level should be at or near its allowed low point in late April in order to provide storage which allows time for treating of higher flow rates to the surge pond during the spring. As described in the preceding section, the water level in the surge pond can be lowered by pumping from either the small or large pumps.

Seasonal flows into the surge pond will vary depending on snow pack and precipitation. In 2006 and 2007, the pumping rates from the surge pond ranged from a maximum of 470 gpm in the spring to no pumping for extended periods in the winter. Generally, surge pond influent pH ranges from 3.2 to 4.2 s.u.

with specific electrical conductivity ranging from 2800 to 3500 µS/cm and zinc concentrations ranging from 80 to 120 mg/l.

4.1.4 Hillside Spring

A natural spring is located at the base of the hillside east of the WTP on the south side of the access road. As presented on Figure 6, the spring is collected in a perforated pipe and concrete sump and then piped to the surge pond as described in Section 4.1.2.

4.1.4.1 Hillside Spring Water Quantity

During much of the year there is no flow from the Hillside spring to the surge pond. However, during snow melt in the spring, flows will begin. In May of 2006 and 2007, flows in excess of 300 gpm were measured. During the late spring and early summer months, capacity will be maintained in the surge pond to accommodate flows from the Hillside spring.

4.1.5 Yak Tunnel Blockage Pumping System

The Yak Tunnel blockage pumping system consists of the blockage pump, currently located in the Black Cloud shaft, and controls which are located within the Black Cloud mine shaft house (shaft house covers the Black Cloud shaft and head frame structure) and the conveyance system which runs from the pump to the WTP. Flows from the Yak Tunnel bulkhead decreased in 2002. In addition, after the suspension of mining and dewatering operations at the Black Cloud mine, groundwater levels rose above the 1330 lateral which connects to the Yak Tunnel. Based on these two events, it is believed that a blockage occurred in the Yak Tunnel in approximately 2002. The water level control program specified in the Additional Investigation Work Plan (MFG, 2004) was implemented in 2005 and 2006. This program consisted of installing submersible pumps in the Black Cloud shaft to dewater the mine pool backed up by the blockage.

The original blockage pumping system consisted of two submersible pumps set approximately at 250 feet and 470 feet below the shaft collar. The installation and maintenance of this system relied on being able to enter the Black Cloud shaft. In November 2007, this pump system failed and a new type of dewatering pump system was installed to preclude future reliance or dependency on re-entering the Black Cloud shaft to service or replace the original submersible pump system.

The installation of a vertical turbine pump in the Black Cloud shaft was completed in January 2008. The bowls of this pump are set at approximately 600 feet below the shaft collar. The pump is controlled by a variable frequency drive (VFD) and is capable of pumping between 500 and 1200 gpm. The VFD and pump are controlled by a local PLC, dedicated phone line, and the WTP control system. The pump water is transferred to a 10-inch diameter HDPE pipeline at the Black Cloud shaft collar which runs from the Black Cloud mine to the WTP. The HDPE pipe is buried for approximately 4 miles and is above ground for approximately the last one-half mile before it enters the WTP. Above ground pipeline sections are self-draining to the WTP and during winter conditions, the above ground pipeline section is insulated by snow cover. Eleven air-vacuum valves along the pipeline release air and prevent a vacuum from collapsing the pipe. Once the blockage water has been pumped up the Black Cloud shaft, it flows by gravity to the WTP. Figure 7 presents a general map of the Blockage conveyance system.

4.1.5.1 Blockage Pump Water Quantity and Quality

The pumping rate of the blockage pumps is dictated by the treatment capacity of the WTP and flow rates from other influent sources. During the late spring and early summer months, blockage pumping will typically be reduced or stopped while water from the Yak Tunnel bulkhead and surge pond is treated. During the fall, winter and early spring the blockage water will be the primary source of influent to the WTP. As discussed above, the blockage pump cannot be operated below 500 gpm, so if the WTP excess capacity is less than 500 gpm during late spring and early summer, the blockage pumps cannot be operated. Generally, Blockage water influent pH ranges from 6.5 to 7.5 s.u. with specific electrical conductivity ranging from 1500 to 2500 µS/cm. During the short pumping history of Blockage water, the zinc concentration has ranged from 20 to 46 mg/l.

4.1.6 Oregon Gulch Seep Water

As part of ongoing operations and maintenance of the remedy for OU10, seepage water collected at the toe of the Oregon Gulch tailing embankment is pumped to the Oregon Gulch pump station and subsequently to the surge pond. The water is pumped though a buried 6-inch diameter HDPE pipeline that runs from the pump station system through the filter building to the surge pond. When pumping ceases, the pump line is designed to drain to either the Oregon Gulch pump station or the surge pond for most of its length; however, where the line enters the filter building it is nearly horizontal and must be insulated and heat taped.

4.1.6.1 Oregon Gulch Water Quantity and Quality

Flows from Oregon Gulch are extremely low when compared to other influent sources. Since 2006, flow rates have ranged from less than 1 gpm to approximately 10 gpm. Flow rates from Oregon Gulch typically increase during the spring snow melt and after precipitation events. Generally, Oregon Gulch trench influent pH ranges from 2.7 to 3.1 s.u. and toe seep influent pH ranges from 3.5 to 5.4 s.u., with the specific electrical conductivity for both ranging from 21000 to 26000 µS/cm.

4.1.7 Potable Water Supply

Potable water is supplied to the WTP for general plant use by the Parkville water supply system. Parkville water supply is provided at the potable supply pump station on South Toledo Street. The pump station is serviced by two pumps, pumps number 1 and 2 are used to pump potable water from the station to the WTP. One pump operates continuously and the remaining pump serves as a standby. Both pumps operate at constant speeds. A recirculation line directs a portion of the pumped flow back to the pump suction end to provide continuous flow for cooling the pump when operating at low supply flows to the treatment plant. The potable water pumps are horizontal, centrifugal, and single stage pumps.

4.1.8 Fire-Protection Pumping Equipment

Skid-mounted fire-protection pumping equipment is located in the potable water pumping station. The fire-protection pump supplies water pressure to the WTP fire-suppression sprinkler system and fire hydrants. The fire-protection pump is a horizontal, centrifugal, single-stage pump which is connected to the Parkville water supply system. The fire-protection pump is furnished with a diesel engine back-up generator.

4.2 Influent Pre-Treatment System

Influent flows to the WTP from the Yak Tunnel bulkhead, Conveyance System, and Yak Tunnel blockage pumps by gravity while influent water from the surge pond is pumped. Treatment at the WTP begins with the influent water entering the WTP and flowing into the first stage reactor (see Figure 1). In the first tank (first stage reactor), the influent (feed water) is mixed and reacted with recycled sludge to neutralize the free acid and precipitate ferric iron and aluminum. If the system is saturated with calcium sulfate, a portion of the calcium sulfate will also be precipitated here. The tank is designed so the feed water enters and exits from the top of the tank after flowing through an upcomer.

4.3 Primary Treatment Process

4.3.1 Neutralization and Alkalization Tanks

As shown on Figure 8, the overflow from the first stage reactor flows into the first of two neutralization tanks. Overflow from the first neutralization tank then flows into the second neutralization tank.

The neutralization tanks provide retention time for the precipitation of metals as hydroxides and for oxidation of ferrous iron and manganese. Both tanks are designed so the feed water enters and exits from the tops of the tanks after flowing through an upcomer. The feed water in the tanks is adjusted to between pH 10.3 and 10.5 using a mixture of recycled sludge and lime slurry, and is not normally corrosive.

The lime slurry used to raise the pH in the neutralization tanks is made in automated batches. Two storage bins, each capable of storing 24 tons of lime, are used to store commercial powdered hydrated lime. The powdered lime is mixed with water to form a slurry which is then fed to the neutralization tanks from the alkalization tank. As part of the automated batch process, metered quantities of potable water and hydrated lime are added to the lime slurry tank when levels in the slurry tank drop below a low level set point. The filling of the slurry tank stops once a high level set point is reached.

The pH in the neutralization tanks is managed by a pH controller. The pH controller automatically controls an air valve which adjusts the quantity of lime added to the neutralization tanks to maintain a pH of 10.3 to 10.5. The pH monitor that controls the lime addition is located on the first neutralization tank. A secondary pH monitor is located on the second neutralization tank and can be selected as the control by the operator.

The lime slurry is added to the neutralization tanks after passing through a small tank (i.e., alkalization tank). The alkalization tank allows time for the lime to react with the recycled sludge before entering the neutralization tanks. Lime slurry and recycled sludge enter the bottom of the alkalization tank, are mixed in the tank, and then exit from the top of the tank through an overflow pipe to the first neutralization tank. An auxiliary pipe is provided to allow alkalized sludge to flow to the second neutralization tank. The auxiliary pipe is not normally used but allows the operator additional flexibility and also allows the first neutralization tank to be bypassed.

Two aeration blowers are used to aerate the neutralization tanks and oxidize the ferrous iron and manganese. Each of the blowers is equipped with a pressure safety relief valve and a pressure indicator. They are also equipped with a check valve to prevent feed water from back flowing to the blowers. The normal air flow is 90 cubic feet per minute (cfm) to each neutralization tank and is controlled by the capacity of the positive displacement blowers.

4.3.2 Flocculation Tank

The water treated in the neutralization tanks flows to the flocculation tank. The flocculation tank provides time for reaction of neutralization tank slurry with polymer addition to form a flocculent. The tank is designed so the feed water enters and exits from the top of the tank after flowing through an upcomer.

Polymer is added to the flocculation tank by pumping a liquid polymer from the polymer makeup tank. Batches of liquid polymer are automatically made by feeding a metered volume of powdered polymer from a hopper to the polymer tank and adding a measured volume of potable water. The hopper is filled when needed by the operator by pouring in powdered polymer from 50 pound bags. Polymer feed rates to the flocculation tank are adjusted based on the settling rate of the flocculent, which is measured daily at the flocculation tank.

4.4 Effluent System

4.4.1 Thickeners

The solution from the flocculation tank is split and diverted to two thickeners arranged in parallel for separation of the solid (sludge) and water phases by gravity settling. The solids are then removed from the bottom of the thickener(s), and the treated water overflows from the top of the thickener(s). Both thickeners send the treated water overflows to the mono-media filter system for filtration and small diameter suspended particle separation. The settled sludge at the thickener bottom is mechanically removed by a rake mechanism, which moves the sludge to the thickener center cone and underflow.

Each thickener is equipped with two sludge recycle pumps, one operating and one spare. The sludge recycle pumps transfer sludge in a loop that goes from the bottom of the thickener (i.e., center cone) through the pumps to the first stage reactor, the alkalization tanks, the mechanical filter press feed pump, and finally back to the thickener. A separate loop is provided for each thickener.

4.4.2 Sludge Dewatering

A recessed plate mechanical filter press is provided to dewater the sludge produced by the precipitation of metal hydroxides. Sludge is pumped from the thickener underflow to the filter press, until a minimum filtrate flow rate is achieved. Air is then used to blow out the press feed lines and to push additional water out of the sludge cake.

The press is then opened, and the sludge cake is dropped from the recessed plates to a dumpster below the filter press. After the sludge cake is removed, the press is closed and the filter press cycle is repeated. There are bomb-bay doors under the filter press to catch any dripping during the fill and press cycle.

4.4.3 Filtrate Effluent Filtration

Treated water overflowing the top of the thickeners contains small quantities of suspended solids. The overflow from the thickeners is piped to three gravity flow mono-media filters which remove any suspended solids that the thickeners did not capture. Normally the flow is split evenly between the three filters except during backwash, when the flow is split between two of the filters while the third filter is backwashing.

Filter effluent (filtrate) gravity flows to a clear well tank. Water stored in this tank is used to supply backwash water for the filters. Each filter is backwashed on a daily basis using filtrate water and an air scour. Air is supplied for backwashing from either the primary or backup air blower. Backwash water which contains the removed suspended solids, is collected in a mudwell, which is then pumped back to the first stage reactor. Both the backwash and mudwell systems have primary and backup pumps.

4.4.4 Filtrate Effluent pH Adjustment

Filtrate overflow from the clear well tank gravity flows to the pH adjustment tank. The pH of the water is adjusted in this tank to between 6.5 and 9.0 s.u. prior to discharge to California Gulch. Sulfuric acid is fed to the pH adjustment tank in varying quantities through a pH control loop. The primary pH probe and controller located at the pH adjustment tank are used for pH adjustment. A secondary pH probe and controller are located on the effluent pipeline (discussed below) and can be used for control if the primary system fails.

4.4.5 Effluent Discharge

Effluent from the pH adjustment tank flows to California Gulch through a 10-inch HDPE gravity flow pipeline. The 10-inch pipeline is single-wall within the WTP and is double contained after leaving through the floor of the WTP. Before leaving the WTP, the pipeline tees, with one leg of the tee going to the surge pond and the second leg going to California Gulch. If water leaving the pH adjustment tank is not between a pH of 6.5 and 9.0, the plant effluent valve closes and the effluent is diverted to the surge pond through the tee. The effluent pipeline is fitted with a 10-inch flow meter to record the quantity of effluent discharged from the WTP.

4.5 Sludge Disposal and Repository

As part of WTP operations, either hazardous or non-hazardous sludge cake is produced. The sludge cake is currently disposed at either the Allied Waste Tower Road facility located near Denver (non-hazardous) or the Clean Harbors Deer Trail facility located near Deer Trail (hazardous). Sampling and analysis of the sludge is discussed in Section 5.1.3.

Historically, sludge from the WTP has been disposed of in Colorado, Nevada, or reprocessed at the Black Cloud mine for metal recovery at out of state smelters. As the Deer Trail facility has been closed in the past, and reprocessing at the Black Cloud mine is no longer an option, additional sludge disposal options are needed.

Construction of a sludge disposal facility within the confines of the California Gulch Superfund site or on the Black Cloud tailing facility will be considered and may be approved upon EPA and the State's determination that appropriate design requirements have been met. The sludge disposal sites that may be evaluated include the Homer, Chapman and Robinson placer mining claims, and the Black Cloud mine tailing area.

4.6 Potential Expansion of or Addition to Existing Treatment Facilities

As part of the reclamation of the Black Cloud Mine pursuant to the Consent Decree, it is anticipated that water from the mine site (tailings facility, seeps, etc.) may be transported to the WTP for treatment prior to discharge. Additional treatment capacity may be needed for treatment of Yak Tunnel influent sources and Black Cloud Mine water in a timely and cost effective manner. To manage these waters, expansion of the existing WTP or construction of a satellite facility is authorized provided that:

1) The expansion or additional facilities will not result in discharge at Outfall 001 that exceeds the limits in Table 1.
2) A work plan is prepared and provided to EPA and the State for comment. The work plan will provide, at a minimum, information on the need for the work, results of treatability study data (if applicable), a conceptual design, and preliminary schedule.
3) Within 60 days, EPA and the State will provide comments on the work plan.
4) A draft construction design submittal will be prepared and submitted to EPA and the State for comment and approval. The construction design submittal shall include, at a minimum, design criteria, results of treatability study data (if applicable), results and analysis of field sampling, pre-design work, preliminary plans and drawings, outline specifications, and an updated schedule. The construction design may be submitted as one or more submittals.
5) Within 60 days, EPA and the State will provide their comments to the construction design submittal, and shall promptly approve the submittal once those comments have been addressed to the satisfaction of the EPA and State.

6) A pre-construction submittal will be prepared and submitted to EPA and the State for approval. This submittal shall include, at a minimum, final construction plans and specifications, draft O&M manual, a project Health and Safety plan (if not covered by the OU1 Health and Safety), and a construction quality assurance plan.

7) Within 30 days, EPA and the State will provide their response to the pre-construction submittal, and shall promptly approve the submittal once those comments have been addressed to the satisfaction of the EPA and State.

8) Before startup of the expansion or additional facility, the O&M plan will be finalized and will include as builts.

5.0 SAMPLING AND ANALYSIS PLAN/QUALITY ASSURANCE PROJECT PLAN

This Chapter addresses requirements for sampling, sample analysis, quality assurance, data validation, recordkeeping and reporting associated with O&M of the OU1 remedy. Further requirements for monitoring the hydrologic conditions associated with the Yak Tunnel and Bulkhead for purposes of implementing the CP are set forth in the RMP, which is attached as Appendix D.

5.1 Water Treatment Plant

The Yak Water Treatment Plant consists of the treatment plant and the potable water/fire pumping station and the process and control equipment contained in these buildings.

5.1.1 WTP Effluent Discharge Point, Sampling Location, and Effluent Limitations

WTP effluent discharge is only authorized at Outfall 001 (shown on Figure 5), which is the outfall from the WTP prior to contact or commingling with any surface and groundwater in the Upper California Gulch drainage. The sampling location for Outfall 001 is the sampling port on the 10-inch HDPE pipe between the pH adjustment tank and where the 10-inch pipe exits the WTP through the concrete floor. Table 1 presents the WTP effluent discharge limitations that apply to the discharge at Outfall 001. This table also provides the frequency and type of sample collection. Section 3.0 provides the definitions of terms in this table and Section 5.8 discusses reporting of sample analysis.

Table 1 Effluent Limitations and Analyses and Influent Analyses

Parameter[a]	Effluent Limitations			
	30-Day Average[b]	Daily Max[b]	Frequency[c]	Sample Type[b]
Flow, MGD	Report	Report	Daily	Continuous
pH, s.u.[d]	6.0-9.0	Report	Daily	Continuous
Oil and Grease, mg/L[e]	Report	10.0	Daily/Weekly	Visual/Grab
Total Calcium, mg/L	Report	Report	Monthly	Composite
Total Magnesium, mg/L	Report	Report	Monthly	Composite
Hardness, mg eq. $CaCO_3$/L[f]	Report	Report	Monthly	Composite
TSS, mg/L	20	30	Monthly	Composite
TSS, lbs/day (kg/day)	240 (109)	360 (163)	Monthly	Composite
Ag- TR, µg/L[H]	Report	Report	Monthly	Composite
Ag- TR, lbs/day (kg/day	Report	Report	Monthly	Composite
Al- AS, µg/L	Report	Report	Monthly	Composite
Al- AS, lbs/day (kg/day)	Report	Report	Monthly	Composite
As- TR, µg/L	Report	Report	Monthly	Composite
As- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Cd- TR, µg/L	50	100	Monthly	Composite
Cd- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Cu- TR, µg/L	150	300	Monthly	Composite
Cu- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Fe- TR, µg/L	Report	Report	Monthly	Composite
Fe- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Hg- T, µg/L[H]	1	2	Monthly	Composite
Hg- T, lbs/day (kg/day)	Report	Report	Monthly	Composite
Pb- TR, µg/L	300	500	Monthly	Composite
Pb- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Mn- TR, µg/L	Report	Report	Monthly	Composite
Mn- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Se- TR, µg/day	Report	Report	Monthly	Composite
Se- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Zn- TR, ug/L	750	1500	Monthly	Composite
Zn- TR, lbs/day (kg/day)	Report	Report	Monthly	Composite
Whole Effluent Toxicity, Acute	g	g	Semi-Annual	Composite
There shall be no discharge of floating solids or visible foam in other than trace amounts.				

T = Total, TR = Total Recoverable, AS = Acid Soluble

a -In addition to monitoring the final discharge at Outfall 001, influent samples shall be taken at the locations described in Section 5.0 and analyzed for all listed parameters

b -See Section 3.0 for definition of terms. For reporting of effluent loading calculations, measurements less than the practical quantitation level shall be considered as zero. For reporting of effluent concentrations, the actual concentration will be reported. If the effluent concentration is less than the PQL, a "<" will be used for the concentration. For influent concentrations, individual water sources will be reported separately. For reporting influent loading calculations, measurements less than the practical quantitation level shall be considered as zero. For reporting of influent concentrations, the actual concentration will be reported. If the influent concentration is less than the PQL, a "<" will be used for the concentration.

c –Operator may request and EPA may allow a change in the monitoring frequency.

d -Daily minimum – daily maximum limitation

e -A grab sample shall also be taken from Outfall 001 if a visual sheen is observed.

f -Hardness shall be calculated using the total calcium and magnesium sample analysis from the monthly samples.

g -Semi-annual acute toxicity in the discharge from Outfall 001 is to be conducted. This testing is alternated between Ceriodaphnia and fathead minnow at each semi-annual test.

h - For the purpose of this plan, the practical quantitation level for total recoverable silver and total mercury is considered to be 1.0 µg/L. Analytical values less than 1.0 µg/L shall be reported as "<" and will be considered to be in compliance with the effluent limitations for total mercury and total recoverable silver. For loading calculations of mercury and silver analytical results, measurements less than the practical quantitation level shall be considered to be zero.

5.1.2 Flow Monitoring

The flow rate of effluent from the WTP is monitored on a continuous basis when discharging to California Gulch. In cases of equipment breakdown, continuous monitoring may not be possible. In these cases, until equipment is repaired, effluent flow monitoring will consist of adding the influent sources together and subtracting estimated treatment losses until equipment is repaired. Such repairs will be completed as soon as practicable.

5.1.3 Filter Cake

As discussed in Section 4.4, a filter or sludge cake is produced as part of WTP operations. The filter cake historically has been classified as hazardous, due to cadmium, using the Toxicity Characteristic Leaching Procedure (TCLP) (method 1311). During 2006 and 2007 it was determined that if the ratio of GIL/SPIL to BIL water was less than 25 percent, the filter cake would classify as non-hazardous using TCLP testing. For example, if the BIL was flowing at 500 gpm, the combination of GIL and SPIL water could not exceed 125 gpm. Additional testing has included the Paint Filter Liquid Test (method 9095A), which the filter cake passed in all analytical tests during 2006 and 2007.

Under current WTP operating conditions, the BIL to GIL/SPIL influent ratio can be maintained for most of the year except during part of May and June. A time lag of approximately one week exists from when influent water ratios are changed before the sludge cake will change from characterizing as non-hazardous to hazardous or visa versa.

At a minimum, TCLP testing of the sludge cake will be performed when the influent ratios are changed. Additional testing will be performed if increases in cadmium are noted in the influent waters or when the GIL/SPIL flows exceed 25 percent of the BIL flows. Sludge samples will be collected from the filter press over a three to four day period, roughly equivalent to one 16 cubic yard truck load, homogenized and sent to the analytical laboratory for analysis.

5.2 Surge Pond

The surge pond consists of the pond itself, the floating barge and pumps, the conveyance system to the WTP, and the filter building. The filter building is no longer used for filtration and is now used to store equipment and house controls for the barge pumps.

5.2.1 Sampling Location

Surge pond water samples are collected from the pipeline inside the WTP at the frequency, and analyzed for the constituents, listed in Table 1.0. Samples will be collected directly from a sampling port on the pipeline before the surge pond water mixes with other waters.

5.2.2 Water Level Monitoring

Surge pond water levels will be monitored by manually reading the staff gauge in the surge pond. Standard Operating Procedure 9 (Appendix A) defines the procedures that will be followed for reading the staff gauge. The staff gauge will be read and the reading recorded a minimum of once every week day. Depending on the pond depth and precipitation or runoff occurring, the staff gauge may be read and recorded more frequently. When the surge pond freezes over during severe cold spells, it may not be possible to do daily water levels.

5.2.3 Flow Monitoring

When surge pond water is being pumped to the WTP for treatment, the flow will be monitored on a continuous basis. In cases of equipment breakdown, continuous monitoring may not be possible. In these cases, until equipment is repaired, surge pond flow monitoring will consist of subtracting the other influent sources from the WTP effluent measurements. Such repairs will be completed as soon as practicable.

5.3 Yak Tunnel Bulkhead

The Yak Tunnel bulkhead consists of the bulkhead itself, the level monitoring equipment, the conveyance system to the WTP, and the Yak Tunnel from the portal to the bulkhead.

5.3.1 Sampling Location

Yak Tunnel water samples will be collected from the GIL pipeline inside the WTP at the frequency, and analyzed for the constituents, listed in Table 1.0. Samples will be collected directly from a sampling port on the pipeline before the Yak Tunnel water mixes with other waters.

5.3.2 Water Level Monitoring

Water levels behind the bulkhead are monitored using the pressure transducer installed in the bulkhead. Water levels will be manually recorded at least once daily.

5.3.3 Flow Monitoring

When Yak Tunnel water is flowing to the WTP for treatment, the flow is monitored on a continuous basis. In cases of equipment breakdown, continuous monitoring may not be possible. In these cases, until equipment is repaired, Yak Tunnel flow monitoring will consist of subtracting the other influent sources from the WTP effluent measurements. Such repairs will be completed as soon as practicable.

5.4 Yak Tunnel Blockage Pumping System

The Yak Tunnel blockage pumping system consists of the blockage pump which is currently installed in the Black Cloud shaft, controls which are located in the Black Cloud mine shaft house, and the conveyance system which runs from the blockage pump to the WTP.

5.4.1 Sampling Location

Blockage water samples will be collected from the Blockage Influent Pipeline (BIL) inside the WTP at the frequency, and analyzed for the constituents, listed in Table 1. Samples will be collected directly from a sampling port on the pipeline before the Blockage water mixes with other waters.

5.4.2 Water Level Monitoring

Water levels will be monitored using a pressure transducer within the Black Cloud shaft. On a quarterly basis, the pressure transducer readings will be verified using hand water level measurements following procedures outlined in SOP-2.

5.4.3 Flow Monitoring

When Blockage water is flowing to the WTP for treatment, the flow will be monitored on a continuous basis. In cases of equipment breakdown, continuous monitoring may not be possible. In these cases, until equipment is repaired, Blockage flow monitoring will consist of subtracting the other influent sources from the WTP effluent measurements. Such repairs will be completed as soon as practicable.

5.5 Laboratory Analytical Methods, Detection Limits, and Reporting Limits

Table 2 presents the method for analysis, method detection limit(s) (MDL), and reporting or practical quantitation limit(s) (PQL) for each analyte that is required to be monitored under this plan. Depending on the laboratory used, the laboratory analytical equipment employed to conduct the requested analysis, and the laboratory QA/QC protocol and analysis; the MDL and PQL limits may change over time. The EPA and CDPHE shall be notified of any changes in the analytical laboratory used and any changes in the MDL or PQL limits as discussed in Section 5.7.

Table 2 Laboratory Analytical Methods, Detection Limits and Reporting Limits

Sample ID	Analyte	Method	Method Detection Limit (mg/L)	PQL (mg/L)
Influent	Calcium-Total	200.7	0.2	1
	Magnesium-Total	200.7	0.2	1
	Total Suspended Solids	2540D	5	5
	Aluminum-Acid Soluble	200.7	0.03	0.2
	Arsenic-Total Recoverable	200.8	0.0005	0.003
	Cadmium-Total Recoverable	200.8	0.0001	0.0005
	Copper-Total Recoverable	200.8	0.0005	0.003
	Iron-Total Recoverable	200.7	0.02	0.5
	Lead-Total Recoverable	200.8	0.0001	0.0005
	Manganese-Total Recoverable	200.7	0.005	0.3
	Selenium-Total Recoverable	200.8	0.001	0.005
	Zinc-Total Recoverable	200.7	0.002	0.1
	Chromium-Total Recoverable	200.8	0.0001	0.0005
	Mercury-Total	245.1	0.0002	0.001
	Silver-Total Recoverable	200.8	0.00005	0.001
Effluent	Calcium-Total	200.7	0.2	1
	Magnesium-Total	200.7	0.2	1
	Total Suspended Solids	2540D	5	5
	Aluminum-Acid Soluble	200.7	0.03	0.2
	Arsenic-Total Recoverable	200.8	0.0005	0.003
	Cadmium-Total Recoverable	200.8	0.0001	0.0005
	Copper-Total Recoverable	200.8	0.0005	0.003
	Iron-Total Recoverable	200.7	0.02	0.05
	Lead-Total Recoverable	200.8	0.0001	0.0005
	Manganese-Total Recoverable	200.7	0.005	0.03
	Selenium-Total Recoverable	200.8	0.001	0.005
	Zinc-Total Recoverable	200.8	0.002	0.005
	Chromium-Total Recoverable	200.8	0.0001	0.0005
	Mercury-Total	245.1	0.0002	0.0002
	Silver-Total Recoverable	200.8	0.00005	0.0002

5.6 Field Measurements and Sampling Procedures

The following sections provide a summary of procedures for field measurements and sampling. The SOPs in Appendix A provide more detailed procedures for this work.

5.6.1 Equipment Calibration, Operation, and Maintenance

The equipment used for monitoring the performance of the WTP, surge pond, Bulkhead, and Blockage mine pool, and for collecting field data during routine monitoring of the Yak Tunnel Hydrologic System includes a variety of stationary and portable instruments. Proper maintenance, calibration, and operation of each instrument shall be required of the WTP operational personnel or field technician(s) conducting routine monitoring activities. All instruments and equipment used to implement the selected remedy will be maintained, calibrated, and operated according to the manufacturer's guidelines and recommendations.

Appendix A contains detailed SOPs on calibration, operation, and maintenance for the following:

- Well Water Level Measurement – SOP-2
- Field Instrument Calibration and Operation – SOP-3
- Surface Water Flow Measurement – SOP-5
- Surge pond Staff Gauge – SOP-9
- Water Level Measurement Using Pressure Transducers – SOP-12

For equipment not covered in the SOPs, the operator will refer to the manufacturer's instructions contained in the Yak Tunnel WTP, Bulkhead, or surge pond O&M manuals. Copies of the O&M manuals are managed and retained per Section 5.8.1 Document Management and Retention. At the WTP, the manuals are located on the bookshelf in the control room.

5.6.2 Sample Identification and Labeling

Samples collected during monitoring, investigations, or RMP activities will be assigned unique sample identification numbers. Each sample identification number will identify the organization collecting the sample or the program under which it is collected, sampling location, type of sample, and sampling sequence for each sample. These numbers are required for tracking the handling, analysis, and verification or validation status of all samples collected during monitoring. In addition, the sample identification numbers will be input into the project database to identify analytical results received from the laboratory. Detailed procedures for sample identification and labeling are provided in SOP-7, Sample Handling, Documentation, and Analysis in Appendix A.

5.6.3 Sample Containers, Preservatives, and Holding Times

The following sections provide information on sample containers, preservatives, and holding times. Additional information is provided in SOP-7, Sample Handling, Documentation, and Analysis in Appendix A. Sample container size and type, the type of preservative, and holding times should be verified with the analytical laboratory prior to sample collection.

5.6.3.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, certified commercially-cleaned sample containers will be obtained from the contract analytical laboratory. The bottles will be labeled as described in the previous section to indicate the type of sample and sample matrix to be collected. In general, 500 ml glass or polyethylene bottles are recommended for the collection of water samples that will be submitted for analysis of the general chemical constituents, major inorganic constituents, and metals.

5.6.3.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Either use of pre-preserved sample bottles from the contract analytical laboratory or sample preservation should be performed immediately upon sample collection to ensure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and when necessary, stored on ice in coolers prior to shipping. Chemical preservatives will be prepared, measured, and added to the sample bottles by the analytical laboratory prior to sample container shipment or the sampler(s) immediately after sample collection. All preservatives used will be provided by the analytical laboratory and use of the preservative should be coordinated with laboratory personnel.

5.6.3.3 Sample Holding Times

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between the sample collection and analysis and/or extraction, based on the nature of the analyte of interest, the preservation method, and chemical stability factors. Samples should be sent to the laboratory as soon as possible after collection by hand delivery or an overnight courier service to minimize the possibility of exceeding holding times. General holding time guidelines are provided in SOP-7, Sample Handling, Documentation, and Analysis in Appendix A.

5.6.3.4 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in previous sections, and when necessary placed on ice in an insulated cooler. The sample containers will be placed in re-closeable plastic storage bags and wrapped in protective packing material. Samples will then be placed right side up in a cooler with ice (double-bagged using plastic trash bags) for delivery to the laboratory.

Samples will be hand delivered or shipped by overnight express carrier for delivery to the analytical laboratory. All samples must be shipped for laboratory receipt and analysis within holding time(s). This may require daily shipment of samples with short holding times.

5.6.4 Sample Documentation and Tracking

Field notes and chain-of-custody (COC) information are an important part of field measurements and sample collection. The procedures for field notes and COC are discussed below and in SOP-7, Sample Handling, Documentation, and Analysis in Appendix A.

5.6.4.1 Field Notes

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, if appropriate, and a permanent record of field activities. Field observations and data collected during routine monitoring activities will be recorded with waterproof ink in a permanently bound field log book with consecutively numbered pages or on field data sheets. Specific information to be recorded and documented is contained in SOP-7.

Changes or deletions in the field book or on the data sheets should be initialed by the person making the correction, recorded with a single strike mark, and remain legible. Sufficient information should be recorded to allow the sampling event to be constructed without having to rely on the collector's memory.

5.6.4.2 Sample Chain-of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the sample(s) are collected until laboratory data are issued. Establishment of traceability of data is crucial for resolving future problems if analytical results are called into question, if these results are used to support litigation, and for minimizing the possibility of sample mix-up.

The primary objective of COC procedures is to create an accurate written record that can be used to trace the possession and handling of samples from the time they are collected through laboratory analysis and their introduction as evidence. Specific procedures to follow and information to be recorded and documented on COC forms is contained in SOP-7. Copies of all COC documentation will be compiled and maintained in the central files for OU1.

5.7 Quality Assurance/Quality Control

Quality assurance and quality control protocols serve to assure that the data collected pursuant to this plan meet specified standards of precision, accuracy, representativeness, comparability, and completeness.

The operator will utilize one or more laboratories to perform chemical analyses of samples collected during the operation and maintenance of the remedy for OU1. The laboratory contracted for analysis of metal chemical constituents must be accredited by the Colorado Certification Program.

The operator will require the laboratory to process all samples submitted according to the specific protocols for sample custody, holding times, analysis, reporting, and associated laboratory QA/QC. The designated laboratory QA/QC specialist and client services representative will maintain contact with the WTP supervisor to ensure that protocols are followed

The laboratories contracted by the operator will be required to allow access to employees of the EPA and State of Colorado and their authorized representatives at reasonable times to inspect or review equipment, practices, or operations regulated or required under this plan.

Over time, the operator may wish to change laboratories that have been contracted to perform sample analyses. If the new laboratory proposes to use a different method from those specified in this plan or a non-EPA method, the operator will submit all protocols to be used for analysis and reporting to EPA and the State of Colorado for approval at least 30 days prior to the commencement of the change.

5.7.1 Quality Assurance/Quality Control Samples

Quality control of field measurement data will involve (1) the collection of QC samples such as field duplicates, equipment rinsate samples, and field blanks, and (2) adherence to the sampling procedures described in the SOPs provided in Appendix A. Due to the significant quantity of historic data and the controlled environment for samples collected within the WTP, **field** QC samples will not be collected with the monthly influent and effluent samples. Internal laboratory QC analysis checks (e.g., spikes, duplicates, blanks, etc.) will still be performed for the monthly WTP samples.

In addition to the collection of field QC samples, adequate control of field measurements will be maintained through adherence to the equipment calibration, operation, and maintenance procedures described in the SOPs provided in Appendix A. Control of documentation practices will be accomplished through routine checking of field books or forms, required checking and sign-off on chain-of-custody forms, and random spot checks of sampling activities for conformance to SOPs.

Laboratory QC checks will include the analysis of blank, duplicate, and matrix spike or matrix spike duplicate samples; calibration checks; and internal standards as required by the analytical methods referenced in Section 5.5, in each individual laboratory's QA Plan, or the State of Colorado Certification Program. In the case of matrix spike and matrix spike duplicate samples, predetermined quantities of stock solutions of certain analytes will be added to a sample matrix by the laboratory prior to sample extraction, digestion and analysis. These samples will then be analyzed to assess analyte stability and recovery throughout the entire analytical procedure.

5.7.2 Data Management

Flow, water level, and water quality data collected during WTP operations, routine monitoring, enhanced monitoring, or additional investigations will be input into a project specific database or remedial action/control specific database(s). The database will be maintained on a computer and structured so that all tasks associated with electronic data transfer from the analytical laboratory, data entry, processing, analysis, and reporting can be accomplished in an efficient and verifiable manner. Data and reports will be maintained and retained as described in Section 5.8.1.

5.7.3 Data Validation

An important part of quality assurance is data validation of the analytical results. The quality of data obtained for WTP compliance monitoring purposes will initially be assessed by comparing the data against historic data and looking for significant deviations. Analytical results will be evaluated to ensure that compliance with sampling procedures and documentation practices described in this plan and the SOPs have been met and that the analytical results are complete. Finally, the precision and accuracy of the data will be evaluated by: (1) calculating the relative percent difference and percent spike recovery, (2) ensuring that holding times have been met, (3) reviewing laboratory blank data for contamination, and (4) a review of reporting or practical quantitation limits.

The relative percent difference (RPD) between sample duplicate and matrix spike sample duplicate samples will be calculated and used to assess analytical precision. An RPD of less than 20 will be required to pass validation.

The RPD for each analyte will be calculated as follows:

$$RPD = \frac{|S - D|}{(S + D)/2} x100$$

Where: RPD = Relative Percent Difference
S = First Sample Value (original)
D = Second Sample Value (duplicate)

In matrix spike analyses, predetermined quantities of stock solutions of certain analytes will be added to a sample matrix prior to analysis. Samples will be split into duplicates, spiked, and analyzed. Percent recoveries will be calculated for each of the analytes spiked. The percent of spike recovery will then be used to estimate the accuracy of results for a given analyte. The percent recovery will be dependent on the analyte and method. For analysis at the WTP, the percent recovery should be between 70 and 130 percent to pass data validation. The percent recovery (%R) of a spiked analyte will be computed according to the following equation:

$$\%R = \frac{(SSR - SR)}{SA} X100$$

Where: SSR = Spiked Sample Result or the measured value for the relevant analyte in the matrix spike sample (total concentration of analyte).
SR = Sample Result or the measured value for the required analyte in the sample on which the matrix spike was performed (concentration of analyte originally present).
SA = Spike Added or the value for the concentration of each analyte added to the sample. The same concentration units must be used for spiked sample results, unspiked (original sample) results, and spike added sample results.

Laboratory blank sample analyte(s) should have an analytical result(s) less than the method detection limit. In some cases data may be usable if the blank sample has an analytical result(s) between the method detection limit and the reporting limit, but these data must be evaluated on a case by case basis.

5.8 Document Control and Reporting

The following sections describe the procedures and protocols that will be used for document control and reporting. These sections apply to this plan, the RMP, and the CP.

5.8.1 Document Management and Retention

The operator shall retain records of all monitoring information, including all calibration and maintenance records, copies of reports, and data generated. A document control system comprised of the following elements will be maintained for the duration of the project.

1) Maintenance of a central file containing all documents pertaining to OU1 work
2) Organization of the documents to facilitate retrieval of information
3) Segregation of documents containing information which are claimed to be privileged or confidential
4) Establishment of procedures to ensure that all required documents are routinely placed in the central file

Prior to November 2005, the WTP operator (ASARCO) established a central filing system at the ASARCO Globe Plant office located at 495 East 51st Avenue, Denver, Colorado 80216. Mr. Glen Anderson of ASARCO or his designated representative was responsible for updating and keeping an inventory of the central files. Starting in November 2005, the current operator established a central filing system at the WTP located at 960 County Road 2, Leadville, Colorado 80461. Duplicates of documents generated since November 2005 and the master file list are also kept at MFG, Inc. located at 3801 Automation Way, Fort Collins, Colorado 80525. The operator will retain those files transferred to it from Asarco LLC containing information that is required to be retained pursuant to this subsection. The operator shall notify EPA and the State in the event of any change in the location of these central files.

The inventory of all required documents contained in the central filing system will be periodically updated. In addition, copies of the documents will be made available to the EPA and the State upon request. The inventory for each document will contain the following information:

- Document date
- Authors, including title and affiliation
- Primary Recipient, including title and affiliation
- Document title or subject
- Summary of document contents
- Number of pages in the document

The central filing system will also contain the following documentation:

- All field measurements, log books, daily check sheets, and notebooks
- Laboratory data reports, which may include (but not be limited to) sample tags, chain-of-custody records, copies of sample tracking records, analysts log book pages, instrument log book pages (including instrument conditions), bench sheets, instrument readout records, computer printouts, chromatography charts, laboratory validation reports, raw data summaries, correspondence, memoranda, document inventory

The operator will permit the EPA, the State, and their authorized representatives to inspect and copy all relevant non-privileged records, files, maps and other documents, writings, or depictions. Any trade secret material claimed as "confidential business information" under 40 Code of Federal Regulations (CFR) Part 2 shall be maintained separately in a locked file. If the EPA, the State, or their authorized representatives view the confidential file, this information will be disclosed to the public only in accordance with 40 CFR Part 2 or Colorado Revised Statute 24-72-204(3)(a)(IV). Such documents are exempt from public access under the Freedom of Information Act and the Colorado Open Records Act.

Adequate records will be maintained to document the process by which project objectives are met. Records kept by the operator will be legible, identifiable, and retrievable and will be protected to the extent possible against loss, damage or deterioration. Access to project files will be restricted to project and other authorized personnel only.

All records in the operator's possession pertaining to OU1 will be preserved for a minimum of ten years after their creation. In the event the operator desires to no longer maintain any such records at the end of the ten-year period, the records will be made available to EPA and the State for inspection and copying at least 90 days prior to such records being discarded.

5.8.2 Document Distribution

All reports or other documents required by this plan to be delivered to the EPA or State shall be transmitted to the following persons:

Distribution List for all notices or other communications required under this plan,

- Remedial Project Manager, U.S. EPA Region 8
- Project Manager, Hazardous Materials and Waste Management Division, Colorado Department of Public Health & Environment
- Case Attorney, Colorado Department of Law
- Yak WTP File

<u>Additional Distribution List for Monthly Discharge Monitoring Report</u>

U.S. EPA Region 8, Policy, Information, Management and Environmental Justice Program (8ENF-PJ), Attention: Director, 1595 Wynkoop, Denver, CO 80202

Any party may change its recipient for notices under this work plan upon 10 days prior written notice to the other parties.

5.8.3 Reporting

Pursuant to this plan, the following reports are required to be prepared and provided to the EPA and the State: monthly progress report, monthly discharge monitoring report (DMR), and annual monitoring report. The required content and format for each of these reports is described below. Distribution of these reports is specified in Section 5.8.2. Reports or other documents required by this plan will be transmitted by United States mail, overnight delivery service, hand delivery, or as otherwise agreed.

5.8.3.1 Monthly Reports

A monthly progress report and discharge monitoring report (DMR) will be prepared and transmitted by the 28th day of the following month. The monthly progress report will be submitted in the format presented in Appendix B and will include the following information:

- A description of major operational activities or changes made during the month, including any changes in activities related to the management of the mine pool and tunnel blockage
- Influent and effluent flow rates, total flows, and analytical analysis
- Chemical usage
- A summary of major mechanical repairs and maintenance activities
- Future or on-going major procurement or engineering projects
- A description of any O&M problems encountered and corrective measures
- Sludge production, management, and the results of analytical testing (if performed)
- On a semi-annual basis, results of acute whole effluent testing
- A copy of monitoring data downloaded tri-annually, as required in the RMP
- For monthly reports that include tri-annually downloaded data, any determination under the CP that enhanced monitoring or additional investigations are required, or that an adverse water condition or hydraulic gradient reversal has occurred.

The monthly DMR will be submitted in the format presented in Appendix C and will include the following information:

- Semi-annual results of acute whole effluent testing submitted on EPA Form 3320-1 Discharge Monitoring Report (DMR)
- Influent and effluent monitoring results and loading calculations for parameters listed in Table 1 submitted on EPA Form 3320-1 Discharge Monitoring Report (DMR)

For both of these reports the concentration and loading calculations and reporting will be performed in the following manner. For reporting of effluent loading calculations, measurements less than the practical quantitation level shall be considered as zero. For reporting of effluent concentrations, the actual concentration will be reported. If the effluent concentration is less than the PQL, a "<" will be used for the concentration. For influent concentrations, individual water sources will be reported separately. For reporting influent loading calculations, less than the practical quantitation level shall be considered as zero. For reporting of influent concentrations, the actual concentration will be reported. If the influent concentration is less than the PQL, a "<" will be used for the concentration.

For the purpose of this plan, the practical quantitation level for total recoverable silver and total mercury is considered to be 1.0 µg/L. Analytical values less than 1.0 µg/L shall be reported as zero and will be considered to be in compliance with the effluent limitations for total mercury and total recoverable silver. For loading calculations of mercury and silver analytical results, measurements less than the practical quantitation level shall be considered to be zero.

5.8.3.2 Annual Reports

An annual monitoring report will be prepared to address the reporting requirements specified in the RMP, attached as Appendix D and to summarize data collected in OU1 during the previous year. This report will be transmitted within 90 days after the end of the calendar year. This report will include the following information:

- Summary of routine and enhanced monitoring activities
- Summary and evaluation of Yak Tunnel bulkhead data including water levels, flows, and water quality data
- Summary and evaluation of bedrock groundwater levels and quality
- Summary and evaluation of Yak Tunnel blockage pumping data
- Conclusions and recommendations

6.0 PROPER OPERATION AND MAINTENANCE

The operator shall operate and maintain the OU1 remedy in accordance with this plan and the incorporated O&M manuals. Proper operation and maintenance of the WTP also includes operation by or supervision of the WTP operations by a State of Colorado Class B certified water treatment plant operator and adequate laboratory controls and appropriate quality assurance procedures. In the event of a material change in the WTP process, operator certification requirements shall be reevaluated pursuant to the Water and Wastewater Facility Operators Certification Requirements outlined in Regulation No. 100 (5 CCR 1003-2). OU1, including the Yak Tunnel Blockage Pumping System, will be maintained and operated according to manufacturers' instructions and EPA-approved O&M manuals and updates that reflect changes and updates to equipment and processes. The operator will periodically update the O&M manuals. The original O&M manuals are hereby incorporated into this Work Plan and consist of the following:

- WTP - Yak Tunnel WTP Leadville, Colorado Operations and Maintenance Manual, Volumes 1 through 6 (Tetra Technologies, Inc., 1992)
- Surge pond - Operations and Maintenance Manual for the surge pond and Filter Unit, Yak Tunnel Operable Unit, California Gulch Site, Volumes 1 and 2 (Woodward-Clyde, 1990)
- Bulkhead – Draft Yak Tunnel Bulkhead Construction and Completion Report & Bulkhead O&M Manual (Lyntek, 1995)
- Blockage – An Operations and Maintenance Manual for the Blockage Pumping System will be provided to EPA within 90 days after the Effective Date of the Consent Decree.

Changes to the O&M manuals that are or will result in a process or operational change will be submitted to the EPA and the State for approval. If conflicts exist between this document and the O&M manuals for sampling, QA/QC, or reporting, the most recent EPA approved document will control.

The operator will inspect the Yak Tunnel from the portal to the bulkhead semi-annually. The inspection will identify any observable collapses, partial blockages or other conditions that would impede access to the bulkhead. Findings from these inspections will be included in the annual report. The operator will take appropriate actions to maintain access to the bulkhead.

6.1 Solid Waste Management

Solid waste collected as screenings, grit, trash and solids that are not required to be treated under this work plan, but are removed in the course of treatment or other daily operations shall be disposed of at a State of Colorado licensed solid waste landfill in accordance with State rules and regulations.

7.0 COMPLIANCE

7.1 Performance Standards

Discharges from Outfall 001 shall meet the effluent limitations set forth in Table 1. Influent sources to the WTP that do not meet the effluent limitations in Table 1 shall be treated to meet those effluent limitations, prior to discharge at Outfall 001. Influent sources to the WTP that meet effluent limitations (Table 1) without treatment, may be routed around the WTP treatment process and discharged at Outfall 001. With prior written approval from EPA and the State, the operator may treat any influent at its source to the discharge standards in Table 1 and discharge without further treatment at the WTP.

Groundwater elevations behind the Yak Tunnel Bulkhead will be maintained at an elevation of between 20 to 35 feet above the tunnel invert, unless modifications to these elevations are approved by EPA and the State.

The operator is currently pumping water from behind the current blockage in the Yak Tunnel to reduce water levels behind the blockage to a level equal to or less than 10,520 feet above mean sea level (amsl) as measured at the Black Cloud shaft. The operator shall continue to diligently pursue drawdown of the water level behind the blockage until this level is achieved. Once this drawdown has been achieved, and except as provided below, water levels behind the current blockage in the Yak Tunnel described in Section 4.1.5 shall be maintained through dewatering efforts at a level at or less than 10,520 feet amsl as measured at the Black Cloud shaft . These elevations are reflective of water levels at the 1330 lateral (the lateral that connects the Irene shaft to the Yak Tunnel) and represent the best estimate of water levels at the suspected blockage down-tunnel from the Black Cloud/Ibex-Irene/Resurrection-Fortune mine pool.

After drawdown has been achieved, water levels behind the current blockage in the Yak Tunnel may rise above the 10,520 feet amsl when (i) it is necessary to shut down pumps at the Black Cloud shaft for routine or emergency maintenance or replacement procedures, or (ii) it is necessary to slow or stop pumping from the Black Cloud shaft to treat other influent streams. In either event, water levels in the Yak Tunnel behind the current blockage will not exceed 10,684 feet amsl, unless approved in writing by EPA and the State. Emergency situations may include, but are not limited to, pump failure, electrical failure, pipeline problems or treatment plant problems.

If the decision-making process under the CP results in additional response action, this Work Plan shall be amended, as appropriate, to establish O & M requirements and performance standards for such additional response action.

7.2 Twenty-Four Hour Reporting

The operator shall report any release of hazardous substances, pollutants, or contaminates as required under Section XIII of the Consent Decree (Reporting Requirements).

In addition, an unanticipated Bypass, Upset, operational error or other circumstance resulting in the discharge of untreated or insufficiently treated water to California Gulch that exceeds any effluent limitation in Table 1 shall be reported by telephone to EPA, Region 8, Water Permits Unit, Sandy Stavnes at 303-312-6117 and the State of Colorado, HMWMD/Remedial Release and Incident Reporting hotline at (877) 518-5608 as soon as possible, but no later than the first workday following the day the operator becomes aware of the circumstance. Unless waived by the EPA Remedial Project Manager, a written report will be provided within 5 working days following the date of the verbal notice. The report shall be submitted to the Discharge Monitoring Report distribution list in Section 5.8.2. The report will contain a description of the release (including the dates and times of release) and its cause or probable cause.

7.3 Inspection and Entry

The operator shall allow the EPA, the State, and their authorized representative(s), upon the presentation of credentials and other documents as may be required by law, access to facilities constructed as part of the OU1 remedy as provided in Section XII of the Consent Decree (Access and Institutional Controls).

7.4 Duty to Mitigate

The operator shall take all practicable actions to minimize or prevent any discharge in violation of this Work Plan or identified effluent limitations.

7.5 Bypass

The following subsections describe when an anticipated Bypass is allowed and the procedures to follow in the event of unanticipated Bypass.

1) Notice.
    a. Anticipated Bypass. If the operator knows in advance of the need for a Bypass, it shall submit prior notice, if possible, at least 30 days before the date of the Bypass.
    b. Unanticipated Bypass. The operator shall submit notice of an unanticipated Bypass as required under Section 7.2 Twenty-Four Hour Reporting.

2) Prohibition of Bypass.

A Bypass is prohibited unless the operator provides notice as provided in paragraph 1 and the following conditions are met:

i. The Bypass is or was unavoidable to prevent loss of life, personal injury, or severe property damage; and

ii. There are or were no feasible alternatives to the Bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a Bypass which occurred during normal periods of equipment down time or preventative maintenance.

3) Approval of Bypass. EPA, after consultation with the State, may approve a Bypass, after considering its adverse effects, if the EPA determines that it meets the two conditions listed above in paragraph 2 of this section.

7.6 Upset Conditions

The following subsections address Upset conditions at the WTP.

1) **Effect of an Upset**. An Upset constitutes an affirmative defense to action brought for noncompliance with the effluent limitations if the requirements of paragraph 2 of this section are met.

2) **Conditions necessary for a demonstration of Upset.** If the operator wishes to establish the affirmative defense of Upset, it shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   a. An Upset occurred and that the operator can identify the cause(s) of the Upset,

   b. The WTP was at the time being properly operated,

   c. The operator submitted notice of the Upset as required under Section 7.2, Twenty-four Hour Reporting, and

   d. The operator has taken all practicable actions to minimize or prevent any discharge in violation of this Work Plan or identified effluent limitations.

3) **Burden of proof.** In any enforcement proceeding, the operator has the burden of proof to establish the occurrence of an Upset

8.0 SITE SAFETY PLAN

The primary purpose of the safety guidelines in this plan is to help prevent personal injury to workers at the WTP and damage to equipment or ancillary Facilities. Potential hazards at the WTP include physical injury via falls or contact with moving parts or equipment, drowning, electrical shock, burns caused by contact with caustic chemicals, and access to oxygen deficient areas.

Safe operation of the WTP begins with proper management. An authority is needed to ensure that safe practices are used at the treatment plant. The Supervisor for the plant is delegated as the authority for plant safety. However, it is the responsibility of every employee to maintain a safe workplace. The supervisor is responsible for seeing that personnel are knowledgeable of potential health hazards at the plant and are aware of safety rules and safe procedures. The supervisor will meet with new employees, suppliers or vendors (before commencing work or WTP service) and detail the health hazards and safety regulations and procedures at the plant. The responsibilities of the employees will also be described in this meeting.

The names and telephone numbers of the local hospitals, ambulances, and fire service will be posted. The names and telephone numbers of manufacturer's representatives who could answer safety questions on specific equipment will be given to the employee. The names and telephone numbers of contacts in case of an employee complaint about plant safety conditions will also be given and posted.

All employees shall be trained in first aid equivalent to the American Red Cross basic first aid training.

A copy of the safety rules will be supplied to the employees, suppliers or vendors. The locations of the operations and maintenance manuals (supplied by the manufacturer), Material Safety Data Sheets, and Hazardous Material Communication Plan (Worker Right-to-know OSHA 1910.1200) for specific equipment and materials will be given to the employees, suppliers and vendors. When (and if) new processes are installed at the plant, it is the supervisor's responsibility to become acquainted with the safe operation and maintenance of the new equipment, and to relay such information to the employees. Material Safety Data Sheets will be kept with the O&M manuals. Basic first-aid equipment will also be available.

The supervisor is responsible for enforcing safety regulations. Infractions of safety regulations should be documented, and if necessary, appropriate disciplinary action be taken. If an employee reports an unsafe condition or act, the situation should be investigated and documented by the supervisor, and corrective action taken if necessary. In general, substandard work practices or conditions must be corrected as soon as possible; those affecting safety will be corrected immediately.

8.1 Employee's Responsibilities

Management of safety by the supervisor at the WTP does not relieve the employees of their responsibility for conducting safe work practices. The employee should know whom to contact for safety questions, where the O&M manuals for equipment are, whom to contact at the plant for first-aid, and the names, locations and telephone numbers of emergency medical services. In general:

1) All written and oral safety rules should be observed and particular job-associated hazards recognized
2) A job should not be started until proper safety instructions have been received and are understood
3) Any hazardous conditions, unsafe equipment, or unsafe working practice must be reported to the supervisor immediately
4) Employees must perform routine, daily pre-shift workplace inspections before beginning daily operations and record the observations of the inspection
5) All injuries or accidents must be reported to the supervisor within 24 hours of occurrence
6) All water in the plant, other than drinking water coolers or faucets provided for potable use, must be considered contaminated and unsafe to drink
7) Running in the plant, except in case of emergency, is forbidden
8) Moving equipment must not be operated unless instruction in its use has been given
9) Speed limits, traffic signs, and parking regulations must be observed within the plant site
10) Safety devices and safety guards must be in place before operating any equipment
11) Hand tools and special tools must be kept clean and in good repair
12) The correct tool must be used for the particular job in the proper manner
13) Proper protective equipment must be used for particular job conditions
14) Wearing loose clothing shall be avoided because it may be caught in moving equipment
15) Good housekeeping shall be practiced at all times
16) The rules of personal hygiene are to be observed to avoid infection
17) Practical jokes, rowdiness, and "horseplay" are strictly forbidden
18) Reporting under the influence of alcohol or drugs, or bringing them on the premises, is forbidden
19) Under no circumstances is safety to be sacrificed for speed
20) No job is considered to be finished until the safety of the next person to use the equipment or facility has been maximized

The general rules of personal hygiene are:

1) Hands and fingers should be kept from the nose, mouth, eyes, and ears

2) Rubber gloves must be worn when cleaning pumps; handling raw water, screenings, sludge, or grit; or for other work in which an employee comes into direct contact with untreated raw water or sludge
3) Gloves always should be worn when hands are chapped or burned or when the skin is broken
4) Before eating or smoking, and after work, hands must be washed thoroughly with soap and hot water
5) Fingernails should be kept short, and foreign material should be removed from the nails with a stiff soapy brush
6) Fresh work clothes should not be stored in a locker with used work clothes. Usually, two lockers are assigned each employee
7) All cuts and scratches must be reported and be given first-aid treatment
8) A shower should be taken after each work day

8.2 Telephone Numbers

The following list of numbers will be posted at the WTP.

EMERGENCY RESPONSE PHONE NUMBERS

General Emergency Numbers:
Fire
Ambulance
Sheriff

St. Vincent General Hospital
West Fourth and Washington, Leadville

Directions to St. Vincent General Hospital from Yak Tunnel: Drive down South Toledo to Fourth, left at Fourth to Washington.

Poison Control Center:

Corporate Resources:

Operator Yak Water Treatment Project Manager
Name (office)
(cell)
(home)

Treatment Plan Site Supervisor
Name (office)
(cell)
(home)

Certified Operator
Name (office)
(cell)

Other Resources:

National Response Center
Superfund/RCRA Hotline
TSCA Hotline
Centers for Disease Control (Day)
(Night)
U.S. EPA Environmental Response Team
Colorado Department of Health (Office Hours)
(24 Hours)

8.3 Potential Hazards

8.3.1 Confined Spaces, Sewers, and Trenches

Production of toxic or explosive gases (and the corresponding decrease in ambient air oxygen content) associated with organic degradation does not seem possible due to the inorganic nature of the treated or untreated water. However, should access (such as via a manhole, tanks, etc.) to a confined space area become necessary, applicable procedures to ensure human safety when entering the contained area must be followed. Such procedures include gas testing equipment, use of non-sparking tools and explosion-proof portable lights, use of self-contained air breathing apparatus, barricading off-entry areas, use of safety harness and life lines, and having a standby rescue crew ready. Air purging techniques of confined areas must be used when dealing with long-time maintenance work in confined areas. Prior to a confined space entry, a completed and signed "Confined Space Entry Permit" must be completed.

No worker will enter a trench or excavation that is deeper than four feet unless the side walls of the trench or excavation has been properly shored or laid back.

8.3.2 Electrical Hazards

Electricity is used to power most unit processes at the WTP. The supervisor must appoint one trained and qualified person (designated person) to respond to all questions and problems dealing with the electrical systems at the plant. Personnel who have not been trained in electrical procedures will not work on electrical equipment.

Any electrical problems encountered at the plant will be referred to the designated person. The designated person should investigate and document the problem, and repair the problem if possible. If the degree of the problem is such that repair is beyond the capabilities of the designated person, an appropriate outside source should be contacted. General work practices include:

1) All persons working on a process system or electrical installation which is powered or serviced by an electrical service or may provide the sudden release or movement of

mechanical equipment or power sources (water, air, etc) must provide and use lock-out switches and tags at all remote locations or where the electrical disconnect or source of the power is located.

2) No individual will remove another persons electrical or safety lockout. Should such an action occur, the individual removing another individuals safety lockout will be subject to severe disciplinary action which may include termination.
3) Electrical equipment and lines must always be considered as energized unless they are positively proven to be de-energized and properly grounded. If it is not grounded, it is not dead.
4) The use of metal ladders or metal tape measures around electrical equipment must be avoided.
5) Two men must work as a team on energized equipment.
6) Use approved rubber gloves on voltages above 300 V.
7) An electrical control panel must never be opened unless the job requires it.
8) Before work is performed on a line or bus that operates at 440 V or above, it must be de-energized, locked out, and grounded in an approved manner.
9) No part of the body may be used to test a circuit.
10) Personnel must avoid grounding themselves in water or on pipes, drains, or metal objects when working on electrical equipment or wiring.
11) No electrical safety device may be made inoperative or bypassed.
12) When working in close quarters, all energized circuits must be covered with insulating blankets.
13) All electrical hand-tools must have double insulated casings and electrical cords shall be free of insulation damage.
14) All electrical equipment must be free from damage and electrical cords shall be free of insulation damage.
15) Metal-cased flashlights shall never be used with or near electric circuitry.
16) Jewelry should not be worn when working with or near electric circuitry.
17) Rubber mats must be used at all control centers and electrical panels and a 3 foot working space must be maintained around the centers at all times.
18) All electric motors, switches, and control boxes must be kept clean at all times.

8.3.3 Mechanical Equipment Hazards

Moving machine parts shall be guarded to at all times to prevent personal contact with moving parts. In the event, mechanical guards must be removed to service or repair the mechanical equipment the equipment will be deenergized and locked out prior to service.

8.3.4 Explosion and Fire Hazards

Common explosion hazards, seen in wastewater plants treating waste with organic chemicals, are not present in the WTP.

In case of fire at the plant, the fire protection sprinkler system will be activated. Fire detectors are located at key positions throughout the building. The number(s) to call in case of fire are listed in Section 8.2 of this plan. Employees should be informed of their roles in fire prevention and control, and the obvious escape routes from the plant.

8.3.5 Sulfuric Acid Hazards

Sulfuric acid is corrosive and should be handled with care and is an irritant to the eyes, noses and throat. If ingested, it can lead to pulmonary edema or bronchitis. Contact with the skin can lead to emphysema, conjunctivitis, stomatis, dental erosion, tracheobronchitis, skin and eye burns, or dermatitis.

First aid steps include:

- Eye - If sulfuric acid contacts the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately.
- Skin - If sulfuric acid contacts the skin, immediately flush the contaminated skin with water, if it penetrates the clothing, immediately remove the clothing and flush the skin with water. Get medical attention promptly.
- Inhalation - If a person breathes large amounts of sulfuric acid vapors, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- Swallow - If a person swallows sulfuric acid, get medical attention immediately.
- Spills - Do not attempt to neutralize sulfuric acid spills by flooding with water.

Special protection information and special handling and storage precautions are listed on the Material Safety Data Sheet.

8.3.6 Oxygen Deficiency and Noxious Gases

If dealing with an oxygen deficient environment, or an area where toxic gases are present (carbon monoxide, diesel emissions, etc.), the following precautions should be taken:

1) If working underground in a toxic gas environment: Proper monitoring, confined space entry procedures, warning devices, barriers, barricades, or guard rails should be followed and in place to protect the public and operators before manhole covers or gratings are removed.
2) If working underground: Trucks and other equipment should be placed to present the least impediment or hazard to traffic. If possible, trucks or equipment should be placed between the working area and oncoming traffic. The vehicles should have a rotating warning light in operation.
3) Manhole covers always should be removed and replaced with approved hooks or hoists.
4) An open flame should never be used to melt ice around and below a manhole cover or any other surface cover.
5) Smoking should not be permitted in any enclosure.
6) Before entering any contained area, a confined entry space permit must be completed, tests for oxygen deficiency and the presence of dangerous gas with approved gas indicators.
7) If the atmosphere is normal, a worker with a safety harness attached to a life line may enter the below surface work area.
8) For extended jobs, forced air ventilation should be used and gas tests should be repeated at intervals depending on the circumstances.
9) While work is in progress in a manhole, two men should be stationed at the surface of the opening to handle the life line if necessary.
10) When a gas or oxygen deficiency is found, the below-surface area should be purged by forcing fresh air into the enclosure before entering. Adequate ventilation must be maintained during work, and tests should frequently be repeated.
11) In an emergency, if it becomes necessary for an employee to enter when gas or oxygen deficiency is present, personnel trained with the use of self-contained breathing apparatus must be used.
12) Extreme care should be taken to avoid all sources of ignition if flammable gas is present. Non-spark tools and shoes with rubbers should be used along with safety lights.
13) A portable, non-conductive ladder should be used wherever space allows, otherwise, in-place units may be used.
14) On first entering, a careful inspection for unsafe conditions should be made. Defects such as cracks and loose bricks in the roof, walls, floor ducts and sumps should be reported to the immediate supervisor.
15) Only one employee at a time should be permitted on a manhole ladder. Others should not stand directly under the ladder.
16) Manhole rungs should be checked and weak or faulty rungs should be reported to the immediate supervisor.

17) If a liquid found in a manhole or vault is thought to be flammable, it should be tested by an approved method. If the liquid is found to be flammable, it should be removed before other work is performed.
18) Each employee should wear proper protective clothing such as hard hat, rubber gloves, and rubber boots.

8.3.7 Laboratory Hazards

A laboratory is not present at the WTP; however, pH, conductivity, and turbidity meters are used at the plant. Samples will be sent out for analysis. Health hazards from the field meter are minimal.

8.3.8 Safety Equipment

Safety equipment is available at the WTP. The supervisor shall inform all employees of the locations of the equipment. The following safety equipment will be available:

1) First-aid kits
2) Fire extinguishers
3) Respiratory protection
4) Protective clothing, including safety goggles, face shields, hard hats, gloves, rubber boots, safety shoes, and rain gear
5) Atmospheric testing equipment to identify oxygen deficiencies and explosive, toxic, and combustible gases
6) Portable air blower system
7) Barricades, cones, warning signs, etc.
8) Full restraint equipment
9) Flotation devices

8.3.9 Process Chemical Handling

The following chemicals are used at the WTP:

1) Hydrated lime is used to raise the pH of various processes. A hydrated lime storage system, pre-mix tank, and feed system are present at the plant.
2) Polymer is added to the flocculation tank to help settle the slurry mixture of influent and recycled sludge. A polymer storage system, a pre-mix tank, and feed system are present at the plant.
3) A sulfuric acid storage and feed system, for raising the pH of the effluent, is present at the plant.

In general, polymer is not hazardous to human health. Sulfuric acid is caustic and should be handled with care, see Section 8.3.5.

Hydrated lime and dust from hydrated lime are irritants, affecting the skin, eyes, mucous membranes, and upper respiratory tract. Plant personnel that will be exposed to working with hydrated lime should observe the necessary safety precautions, which include those listed below:

1) Dust from hydrated lime can be very irritating if inhaled. Where dust concentrations are prevalent, approved respirators should be worn.
2) Approved eye protection is required for working with hydrated lime. Workers can wear either tight-fitting safety glasses with side shields or goggles.
3) Besides using eye protection and respirators, workers exposed to hydrated lime should be fully clothed. Workers should wear long-sleeved shirts with both the collar and sleeves buttoned. Trousers should be cuff less and have legs long enough to fit over the tops of shoes or boots (low shoes should not be worn). Clothing should not bind too tightly around the neck, wrists, or ankles. Approved protective gloves should also be worn.
4) The use of sweatbands is advisable to prevent perspiration that mixes with hydrated lime dust, from trickling into the eyes.
5) Workers should shower after handling hydrated lime. If clothes are permeated with dust or splattered with hydrated lime slurry, they should be removed and laundered. Clean clothes should be worn every shift.

Safety instructions from the manufacturer or suppliers of the chemicals, Material Safety Data Sheets and the O&M manuals for the chemical systems should be read by employees who will be working on the chemical systems Material Safety Data Sheets for the chemicals used in the plant are stored with the O&M manuals.

8.3.10 Fall Protection

This section presents general guidelines for basic fall protection when working in elevated areas. During elevated work, the precautions below must be taken.

- All fall hazards should be identified at work sites with the potential for elevated work. Once an elevated fall hazard has been recognized, an appropriate control measure must be selected. Priority should be given to elimination of the fall hazard over the use of fall protection equipment.
- Approved safety harnesses and lanyards shall be worn by employees whose work exposes them to falls of greater than 6 feet.
- All fall protection devices should be used only in accordance with manufacturer's recommendations.
- All fall protection devices shall be inspected daily before use.
- Any lifeline, harness, or lanyard actually subjected to in-service loading (a fall) should be immediately removed from service and not used again for employee fall protection.
- Employees who are required to wear fall protection should be trained in the use of the equipment, as well as in fall protection work practices.

- The system must limit maximum arresting force on an employee to 1,800 pounds when used with a body harness.
- The system must be rigged so that an employee cannot free fall more than 6 feet or come in contact with any lower level in the event of a fall.
- The system must bring an employee to a complete stop and limit maximum deceleration distance an employee travels to 3.5 feet.
- The system must have sufficient strength to withstand twice the potential impact energy of an employee free falling a distance of 6 feet or the free-fall distance permitted by the system, whichever is less.

8.3.11 Portable Ladder Safety

This section applies to portable ladders only. Fixed ladder systems shall be used when regular access is required such as for entering storage tanks and raised work platforms. Procedures to ensure portable ladder safety are listed below.

- Ladders should be maintained in good condition at all times. Damaged ladders shall be withdrawn from service immediately.
- Ladders should be inspected regularly and removed from service and repaired or discarded if defective.
- Rungs should have slip-resistant surfaces and be kept free of grease and oil.
- Tops and pail shelves of portable stepladders should not be used as steps.
- Rung and cleat ladders should be placed so that the horizontal distance from the top support to the foot of the ladder is one-quarter of the working length of the ladder.
- Ladders should not be placed in front of doorways, drives, or passageways.
- Ladders should not be placed on boxes, barrels, or other unstable bases to add height.
- Employees should always face the ladder during ascent or descent.
- Metal ladders should not be used in areas with the potential for contact with electric circuits.
- Ladder side rails shall extend at least 3 feet above the upper landing surface to which the ladder is used to access.
- Ladder shall be used only on stable and level surfaces. Do not use ladders on slippery surfaces.

8.3.12 Cold Stress

This section describes situations where cold stress is likely to occur and discusses procedures for the prevention and treatment of cold-related injuries and illnesses. Cold conditions may present health risks to employees during field activities. The two primary factors that influence the risk potential for cold stress are temperature and wind velocity. Wetness can also contribute to cold stress. Other factors that increase susceptibility to cold stress, include age (very young or old), smoking, alcohol consumption, fatigue, and wet clothing. Hypothermia can occur at temperatures above freezing if the individual has on wet or damp clothing or is immersed in cold water. The combined effect of temperature and wind can be evaluated using a wind chill index as shown in Table 3.

Table 3 Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature

Estimated Wind Speed (in mph)	**Actual Temperature Reading (°F)**											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect).	LITTLE DANGER in less than 1 hour with dry skin; maximum danger from false sense of security				INCREASING DANGER from freezing of exposed flesh within 1 minute			GREAT DANGER that flesh may freeze within 30 seconds				

Source: Modified from American Conference of Governmental Industrial Hygienists. 1997. "Threshold Limit Values for Chemical Substances and Physical Agents."

Bare flesh and body extremities that have high surface area-to-volume ratios such as fingers, toes and ears are most susceptible to wind chill or extremely low ambient temperatures. Because cold stress can create the potential for serious injury or death, employees must be familiar with the signs and symptoms and various treatments for each form of cold stress. Table 4 provides information on frostbite and hypothermia, the tow most common forms of cold-related injuries.

Table 4 Cold Stress Conditions

Condition	Causes	Signs and Symptoms	Treatment
Frostbite	Freezing of body tissue, usually the nose, ears, chin, cheeks, fingers, or toes	• Pain in affected area that later goes away • Area feels cold and numb • Incipient frostbite (frostnip) – skin is blanched or whitened and feels hard on the surface • Moderate frostbite – large blisters • Deep frostbite – tissues are cold, pale and hard	• Move affected worker to a warm area • Immerse affected body part in warm (100 to 105 °F) water – not hot! • Handle affected area gently; do not rub • After warming, bandage loosely and seek immediate medical treatment
Hypothermia	Exposure to freezing or rapidly dropping temperatures	• Shivering, dizziness, numbness, weakness, impaired judgment, and impaired vision • Apathy, listlessness, or sleepiness • Loss of consciousness • Decreased pulse and breathing rates • Death	• Immediately move affected person to warm area • Remove all wet clothing and redress with loose, dry clothes • Provide warm, sweet drinks or soup (only if conscious) • Seek immediate medical treatment

When working in cold environments, specific steps should be taken to lessen the chances of cold-related injuries. These include the following:

- Protecting of exposed skin surfaces with appropriate clothing (such as face masks, handwear, and footwear) that insulates, stays dry, and blocks wind.
- Shielding the work area with windbreaks to reduce the cooling effects of the wind.
- Providing equipment for keeping workers' hands warm by including warm air jets and radiant heaters in addition to insulated gloves.
- Using adequate insulating clothing to maintain a body core temperature of above 36 °C.
- Providing extra insulating clothing on site.
- Reducing the duration of exposure to cold.
- Changing wet or damp clothing as soon as possible.

8.3.13 Heat Stress

This section describes situations where heat stress is likely to occur and provides procedures for the prevention and treatment of heat-related injuries and illnesses. Wearing personal protective equipment (PPE), especially during warm weather, puts employees at considerable risk of developing heat-related illness. Health effects from heat stress may range from transient heat fatigue or rashes to serious illness or death.

May factors contribute to heat stress, including PPE, ambient temperature and humidity, workload, and the physical condition of the employee, as well as predisposing medical conditions. However, the primary factors are elevated ambient temperatures in combination with fluid loss. Because heat stress is one of the more common health concerns that may be encountered during field activities, employees must be familiar with the signs, symptoms, and various treatment methods of each form of heat stress. Heat stroke is the most serious heat-related illness – it is a threat to life and has a 20 percent mortality rate. Direct exposure to sun, poor air circulation, poor physical condition, and advanced age directly affect the tendency to heat stroke. Table 5 lists the most serious heat conditions, their causes, signs and symptoms, and treatment.

Table 5 Heat Stress Conditions

Condition	Causes	Signs and Symptoms	Treatment
Heat cramps	Fluid loss and electrolyte imbalance from dehydration	• Painful muscle cramps, especially in legs and abdomen • Faintness • Profuse perspiration	• Move affected worker to a cool location • Provide sips of liquid such as Gatorade® • Stretch cramped muscles • Transport affected worker to hospital if condition worsens
Heat Exhaustion	Blood transport to skin to dissipate excessive body heat, resulting in blood pooling in the skin with inadequate return to the heart	• Weak pulse • Rapid and shallow breathing • General weakness • Pale, clammy skin • Profuse perspiration • Dizziness • Unconsciousness	• Move affected worker to cool area • Remove as much clothing as possible • Provide sips of liquid such as Gatorade® (only if conscious) • Fan the person but do not overcool or chill • Treat for shock • Transport to hospital if condition worsens
Heat Stroke	Life threatening condition from profound disturbance of body's heat-regulating mechanism	• Dry, hot and flushed skin • Constricted pupils • Early loss of consciousness • Rapid pulse • Deep breathing at first, and then shallow breathing • Muscle twitching leading to convulsions • Body temperature reaching 105 or 106 °F or higher	• Immediately transport victim to medical facility • Move victim to cool area • Remove as much clothing as possible • Reduce body heat promptly by dousing with water or wrapping in wet cloth • Place ice packs under arms, around neck, at ankles, and wherever blood vessels are close to skin surface • Protect patient during convulsions

When working in hot environments, specific steps should be taken to lessen the chances of heat-related illnesses. These include the following:

- Ensuring that all employees drunk plenty of fluids (Gatorade® or its equivalent)
- Ensuring that frequent breaks are scheduled so overheating does not occur
- Revising work schedules, when necessary, to take advantage of the cooler parts of the day

When PPE must be work (especially Levels A and B), suggested guidelines relating to ambient temperatures and maximum wearing time per excursion are as shown in Table 6.

Table 6 Suggested Guidelines when Wearing PPE

Ambient Temperature	Maximum PPE Wearing Time per Excursion
Above 90 °F	15 minutes
85 to 90 °F	30 minutes
80 to 85 °F	60 minutes
70 to 80 °F	90 minutes
60 to 70 °F	120 minutes
50 to 60 °F	180 minutes

Source: National Institute for Occupational Safety and Health (NIOSH). 1985. Memorandum Regarding Recommended Personal Protective Equipment Wearing Times at Different Temperatures. From Austin Henschel. To Sheldon Rabinovitz. June 20.

9.0 GENERAL REQUIREMENTS

9.1 Planned Changes

The operator shall include in the monthly progress reports a description of any physical alterations or additions to the WTP or other Facilities. The operator shall provide notice to, and gain approval from, EPA and the State prior to construction when the alteration or addition would significantly change the nature or increase the quantity of pollutants discharged from the WTP or other facilities. The operator shall furnish the EPA and State such plans and specifications reasonably necessary to evaluate the effect of the discharge on the receiving stream. The EPA and State may approve any such alterations or additions to the facilities by written notice to the operator.

9.2 Signatory Requirements

All reports or information submitted to the EPA or State shall be signed. The DMR shall be signed and certified.

1) All reports required by this plan shall be signed by the operator's Project Manager or by a duly authorized representative of that person. A person is a duly authorized representative only if:
    a. The authorization is made in writing by the operator's Project Manager and submitted to the EPA and State, and
    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position).
2) Changes to authorization. If an authorization under paragraph 1) is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph 1) must be submitted to the EPA and State prior to or together with any reports, information, or applications to be signed by an authorized representative.
3) Certification. Any person signing a document under this section shall make the following certification:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete.

10.0 CONTINGENCY PLAN AND ROUTINE MONITORING PLAN

The Routine Monitoring Plan and Contingency Plan are generally discussed in this section and are attached to this plan as Appendix D and E, respectively. The Routine Monitoring Plan provides for the collection of long term monitoring information on the Yak Tunnel Hydrologic System to allow for evaluation of changes in the system and the potential need for response actions. The Contingency Plan provides the decision-making process for evaluating the monitoring data, and determining the need for expanded monitoring or response actions to address significant changes.

In many cases, procedures and protocols contained in this document also pertain to and will be followed for the RMP and CP. These procedures include Sections 5.6 Field Measurements and Sampling Procedures, 5.7 Quality Assurance/Quality Control, 5.8 Document Control and Reporting, and Appendix A - Standard Operating Procedures.

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FIGURES

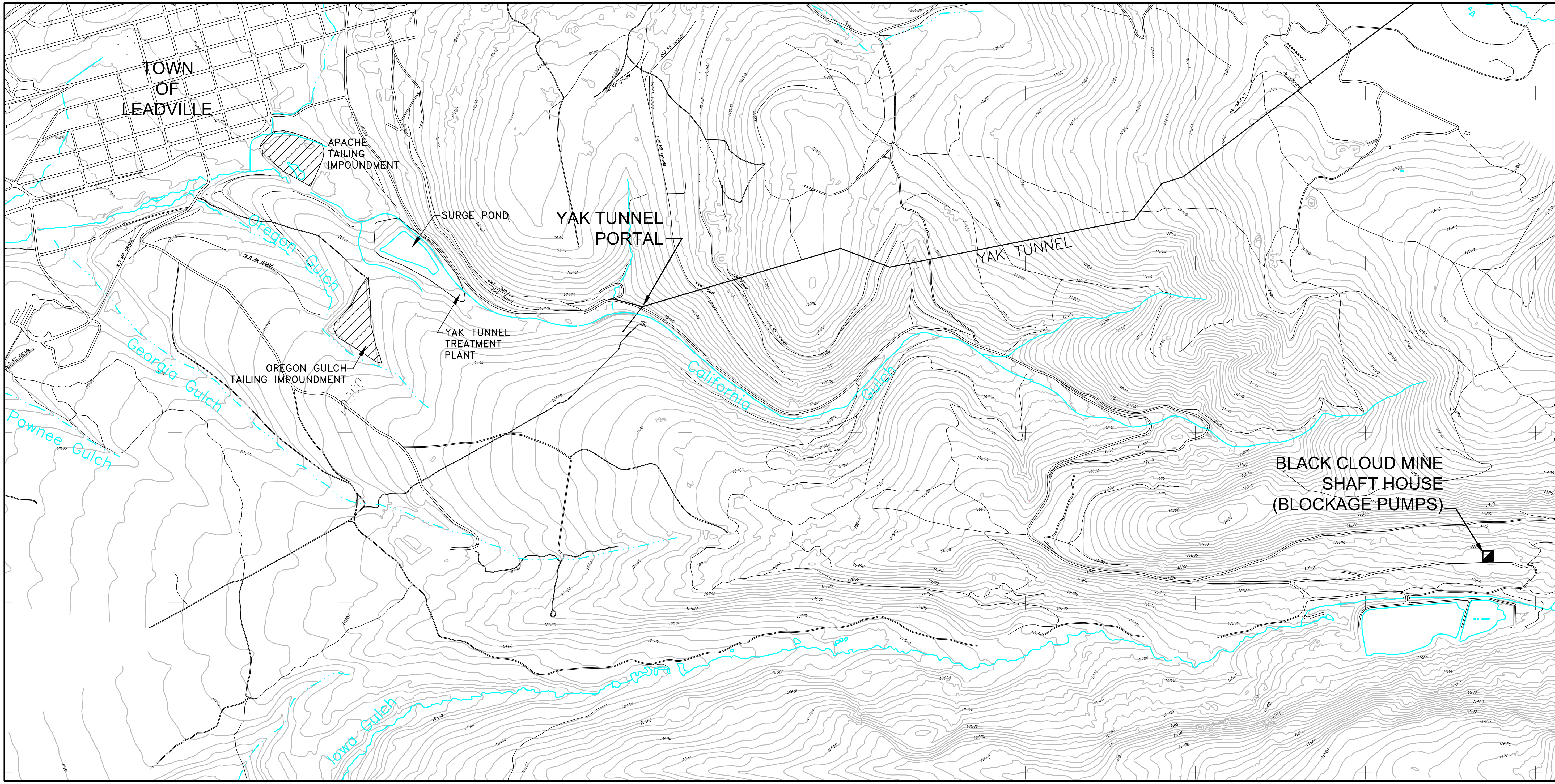

FIGURE 1
OVERVIEW OF OU1 REMEDIES

MFG, Inc.
consulting scientists and engineers

Date: MAY 2008
Project: 180885/37
File: PLAN-001.DWG

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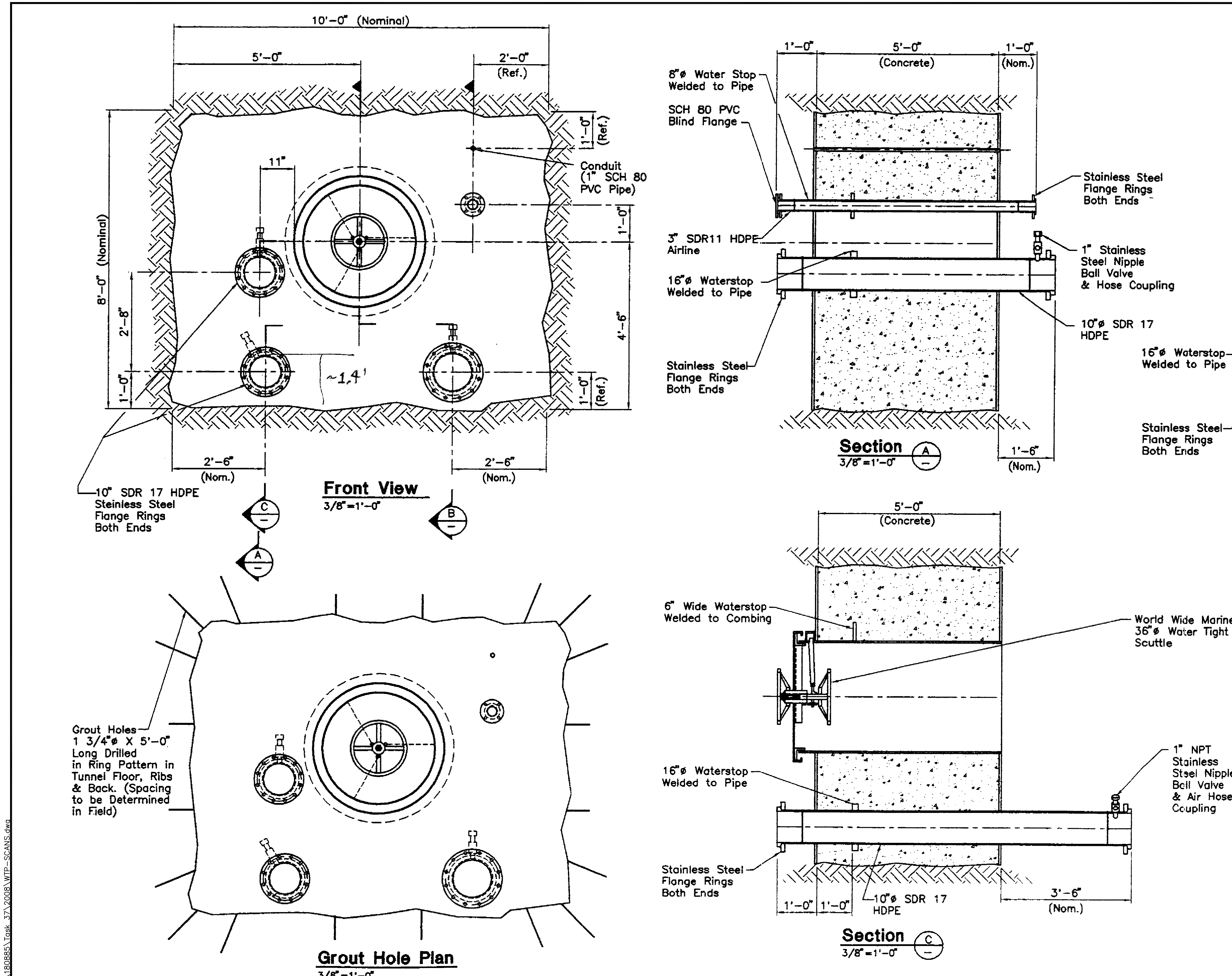

FIGURE 2
BULKHEAD DESIGN

MFG, Inc.
consulting scientists and engineers

Date:	MAY 2008
Project:	180885/37
File:	WTP-SCANS.dwg

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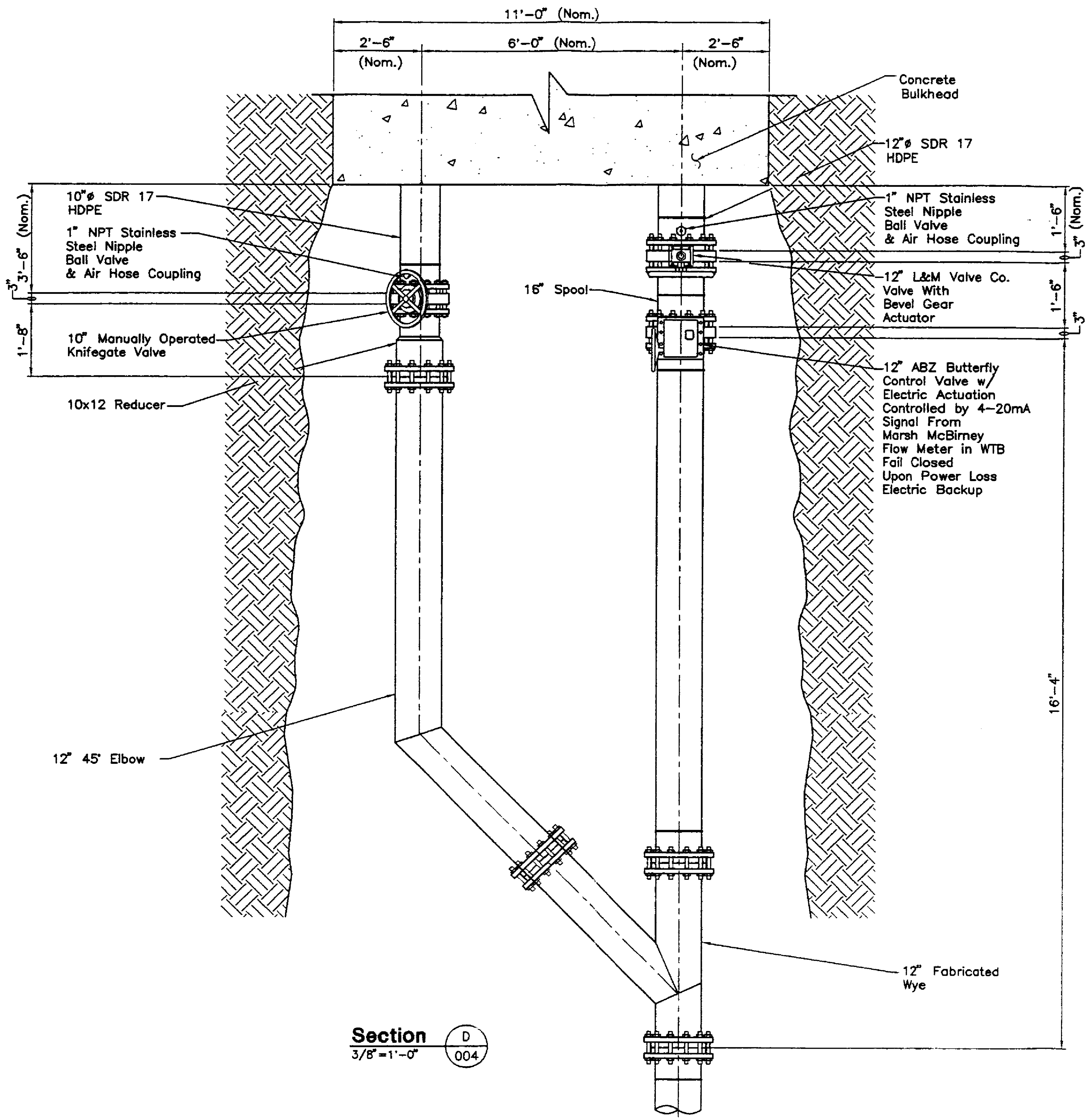

FIGURE 3
BULKHEAD FLOW
THROUGH PIPE DESIGN

MFG, Inc.
consulting scientists and engineers

Date:	MAY 2008
Project:	180885/37
File:	WTP-SCANS.dwg

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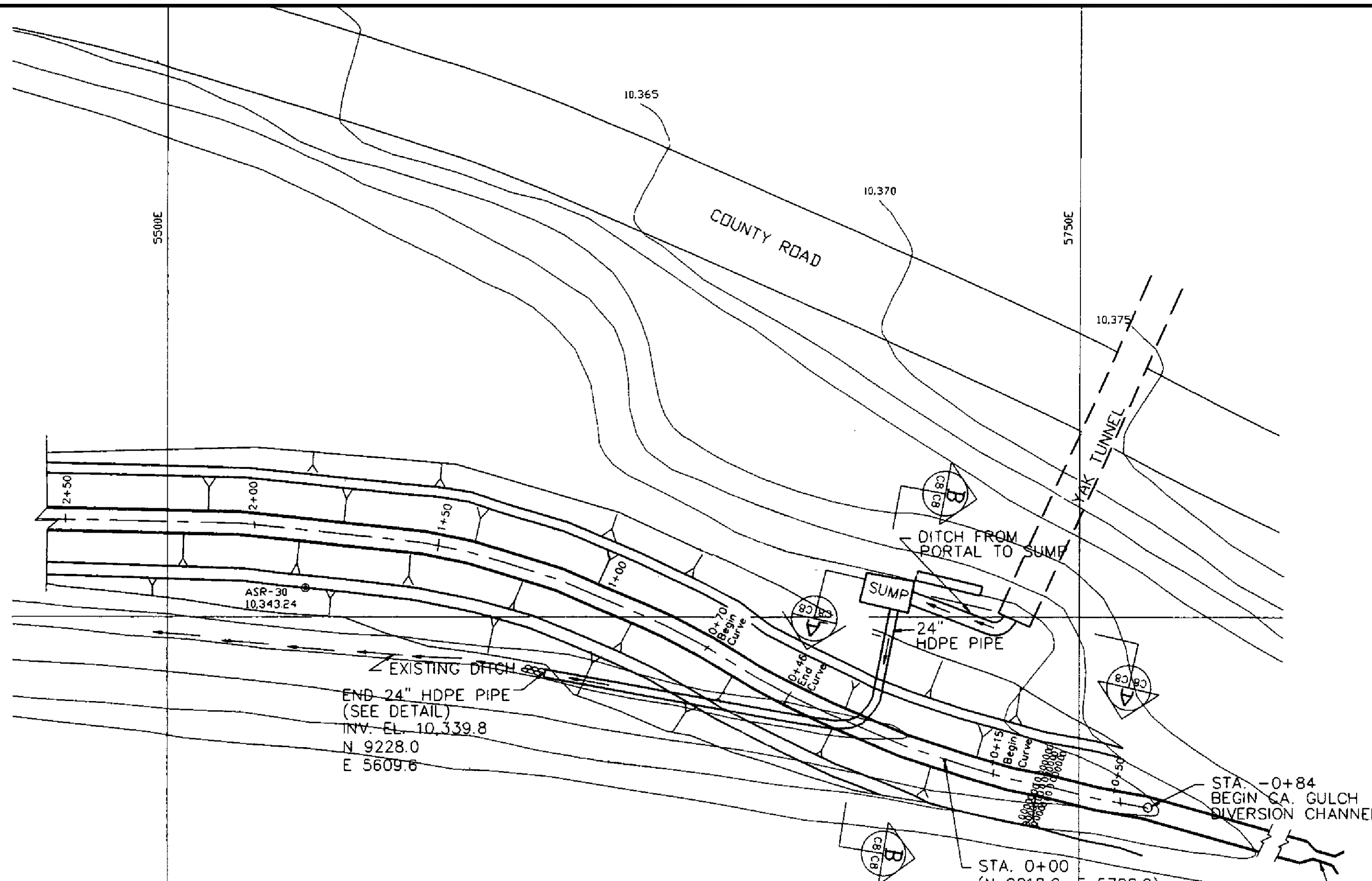
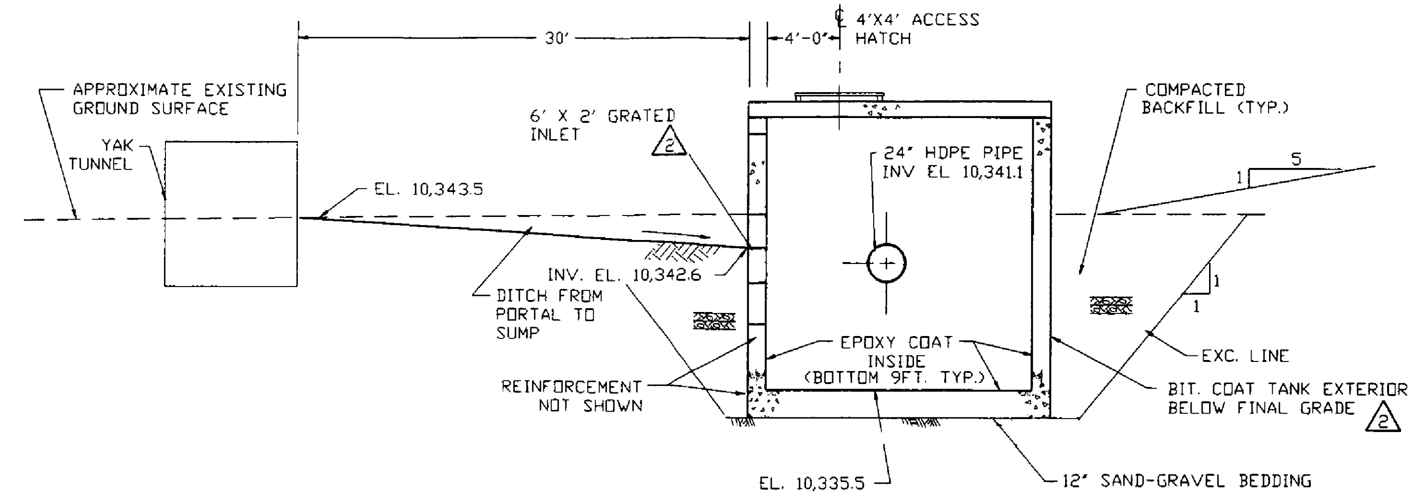


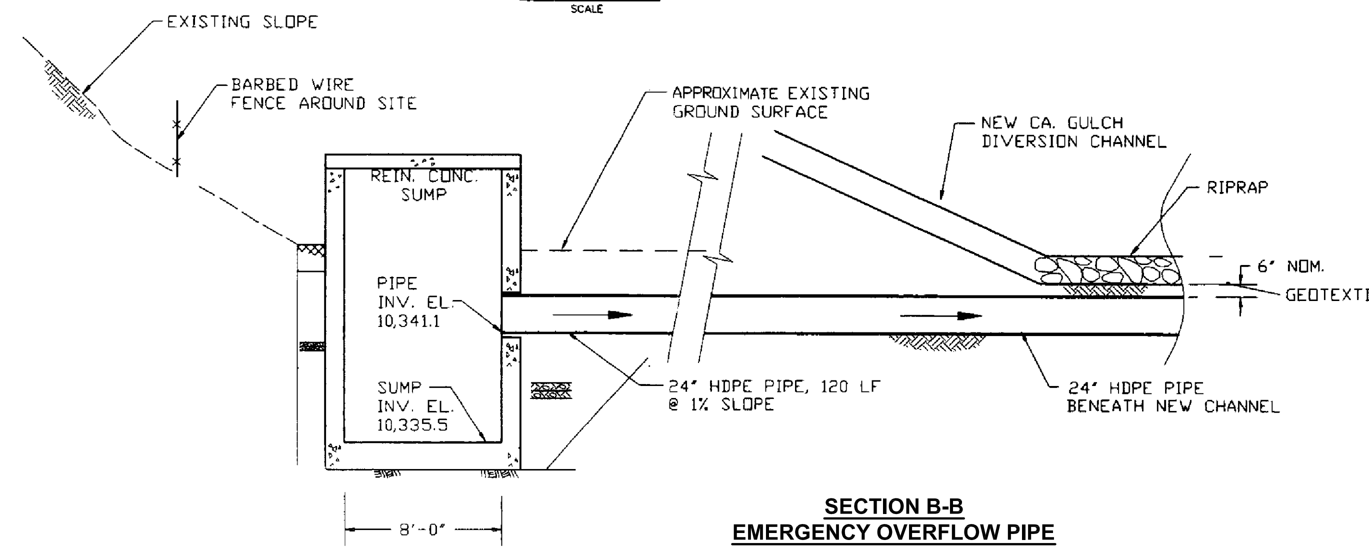
PLAN

0 50 FEET SCALE



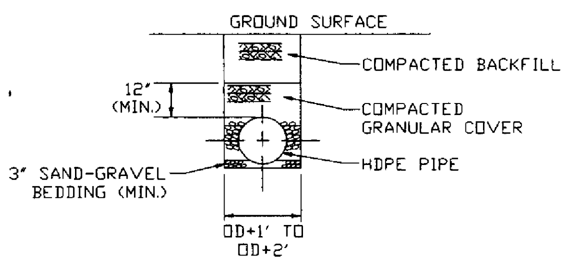
SECTION A-A
OUTLET DRAIN FROM YAK TUNNEL

2.5 0 5 FEET SCALE



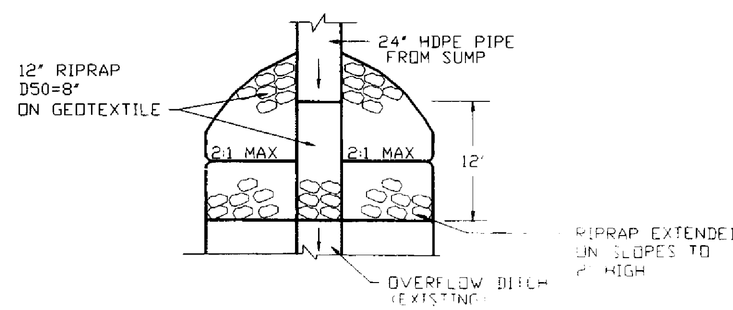
SECTION B-B
EMERGENCY OVERFLOW PIPE

2.5 0 5 FEET SCALE



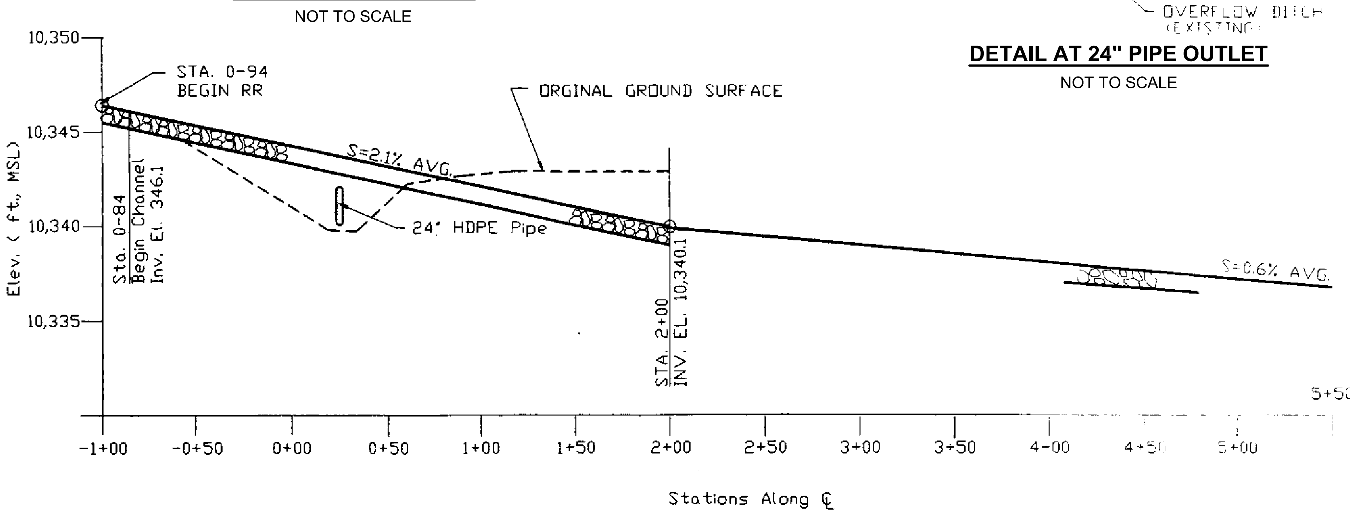
TYPICAL PIPE TRENCH

NOT TO SCALE



DETAIL AT 24" PIPE OUTLET

NOT TO SCALE



UPPER CALIFORNIA GULCH CHANNEL PROFILE

FIGURE 4
YAK TUNNEL
CONVEYANCE SYSTEM

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Date:	MAY 2008
Project:	180885/37
File:	WTP-SCANS.dwg

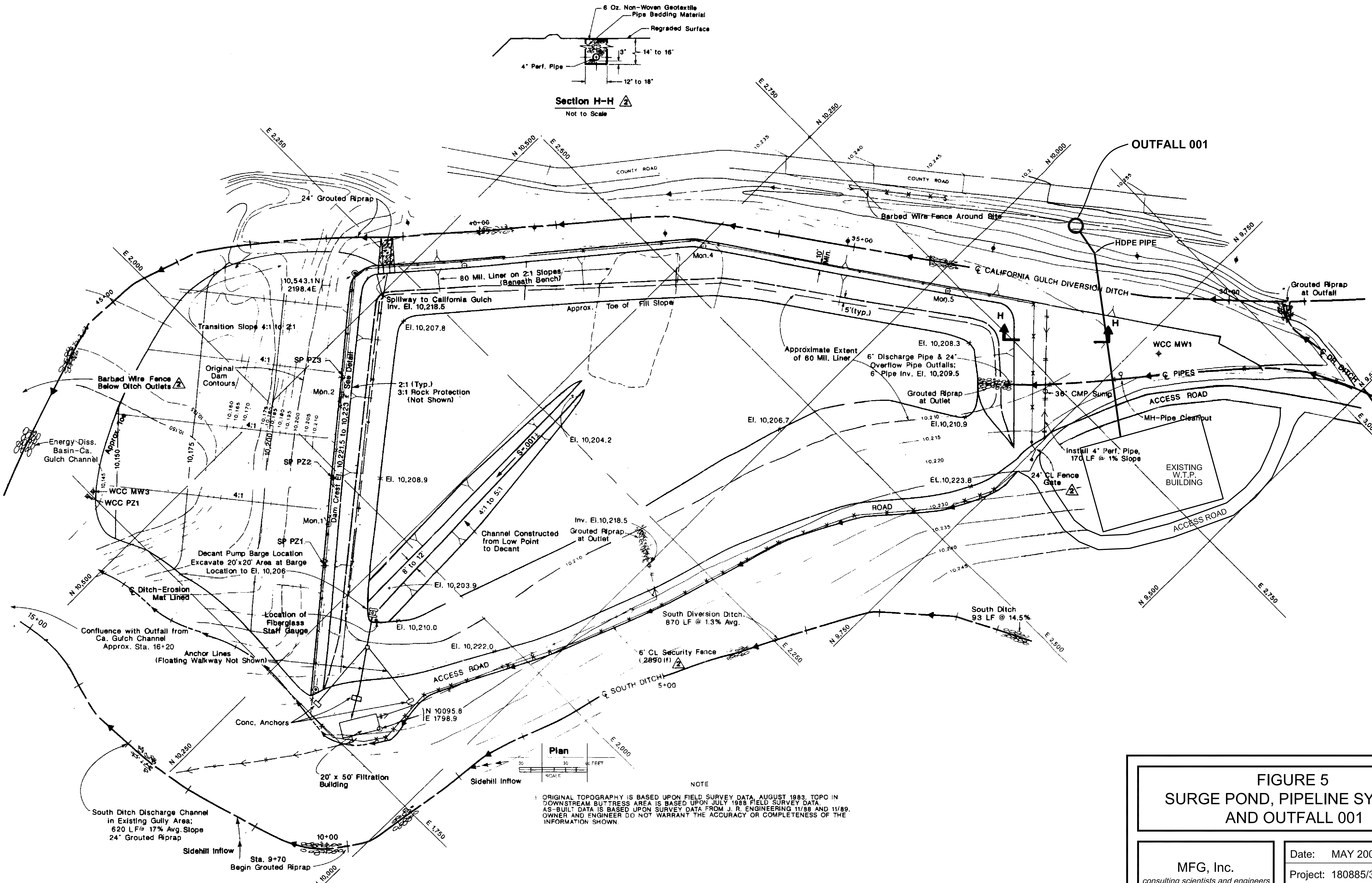

FIGURE 5
SURGE POND, PIPELINE SYSTEM, AND OUTFALL 001

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consulting scientists and engineers

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Project:	180885/37
File:	WTP-SCANS.dwg

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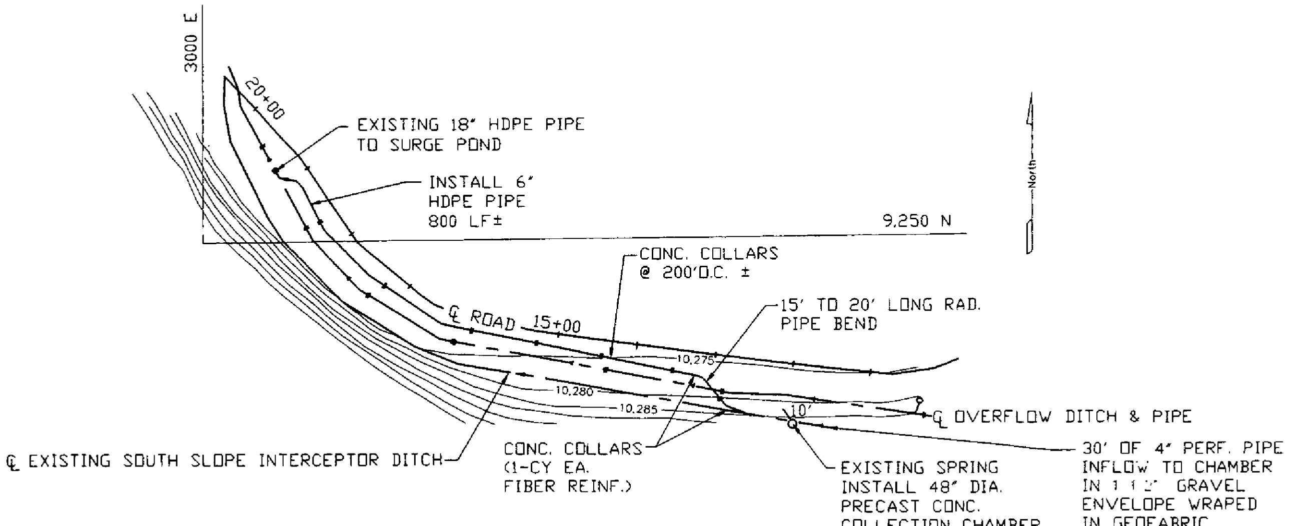
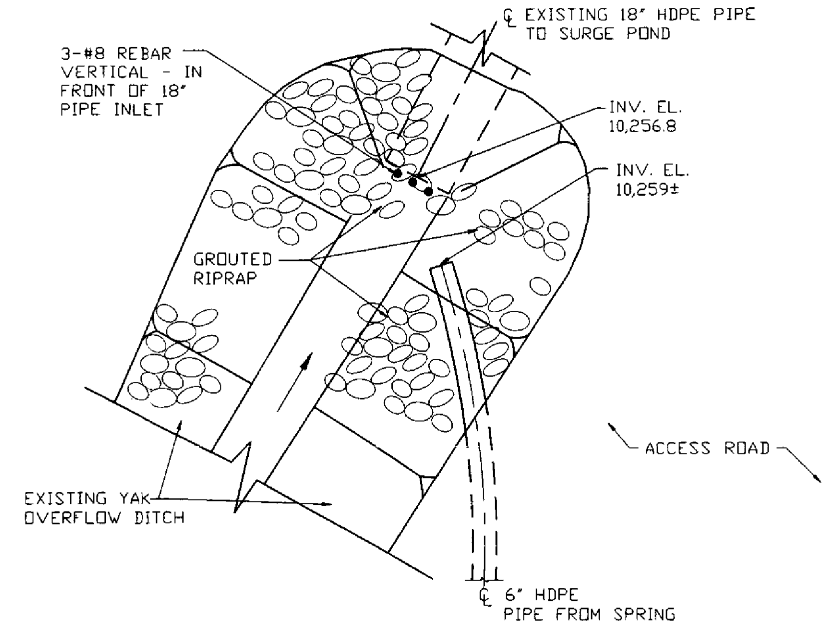


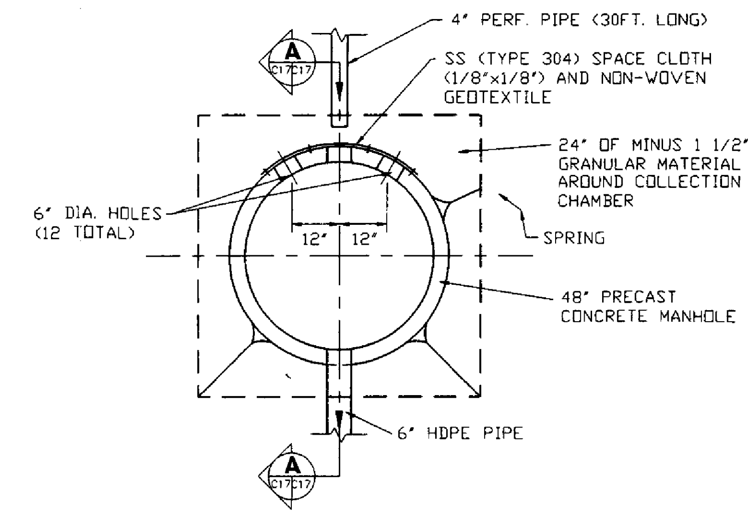
PLAN

50 0 40 80 120 FEET
SCALE



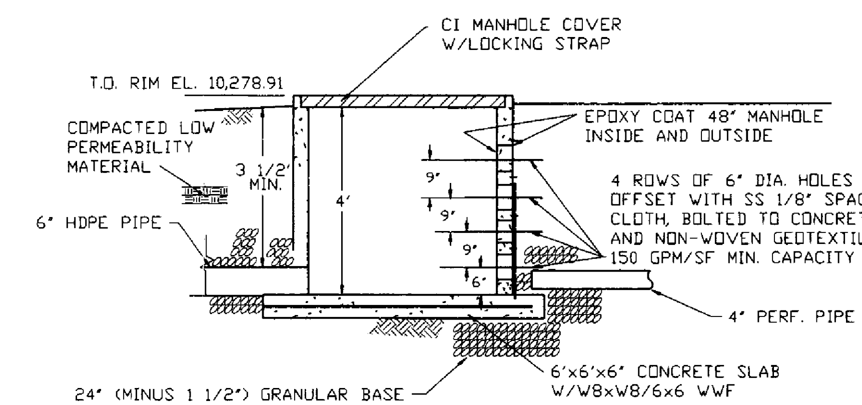
PLAN AT 6-INCH PIPE OUTLET

NOT TO SCALE



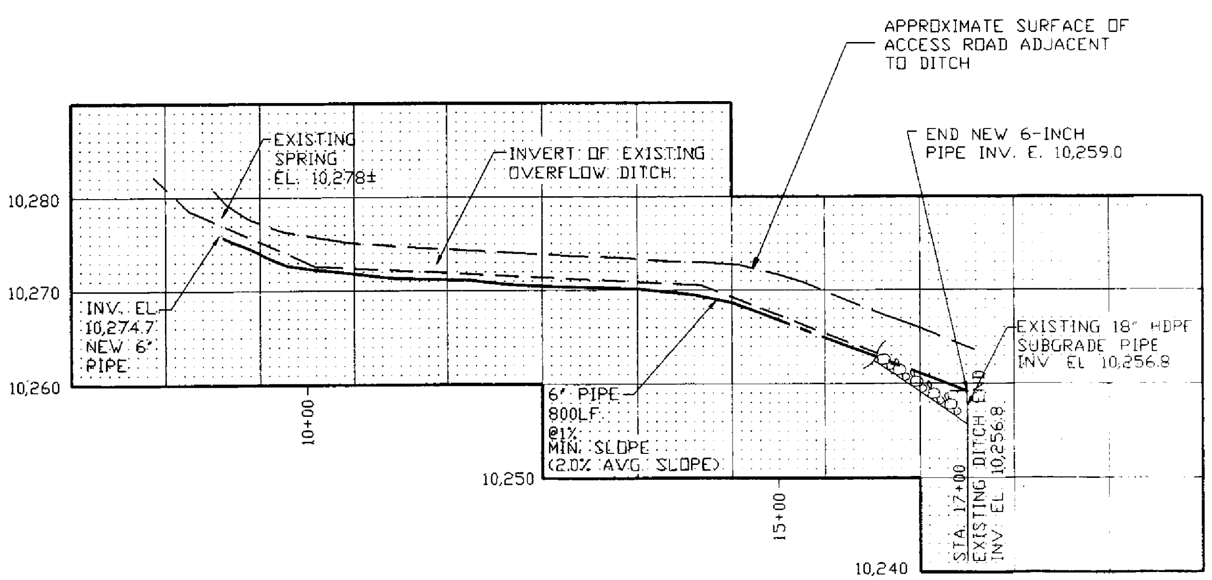
PLAN - SPRING COLLECTION

0 6 12 18 24 INCHES
SCALE

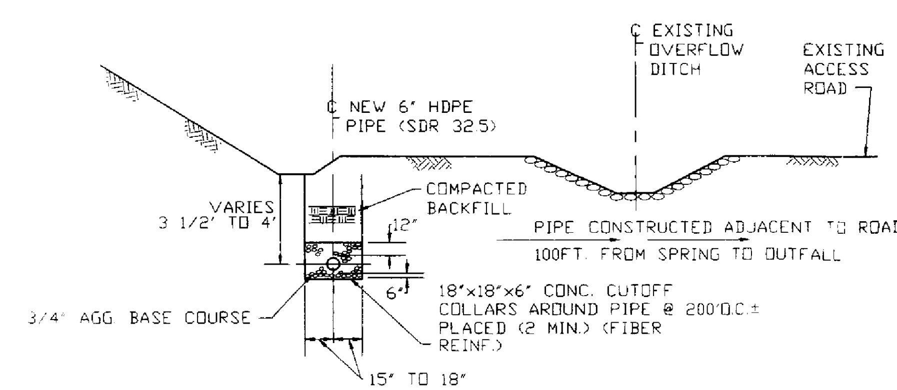


SECTION A-A'

0 6 12 18 24 INCHES
SCALE



PROFILE



TYPICAL PIPE TRENCH

NOT TO SCALE

FIGURE 6
HILLSIDE SPRING

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File:	WTP-SCANS.dwg

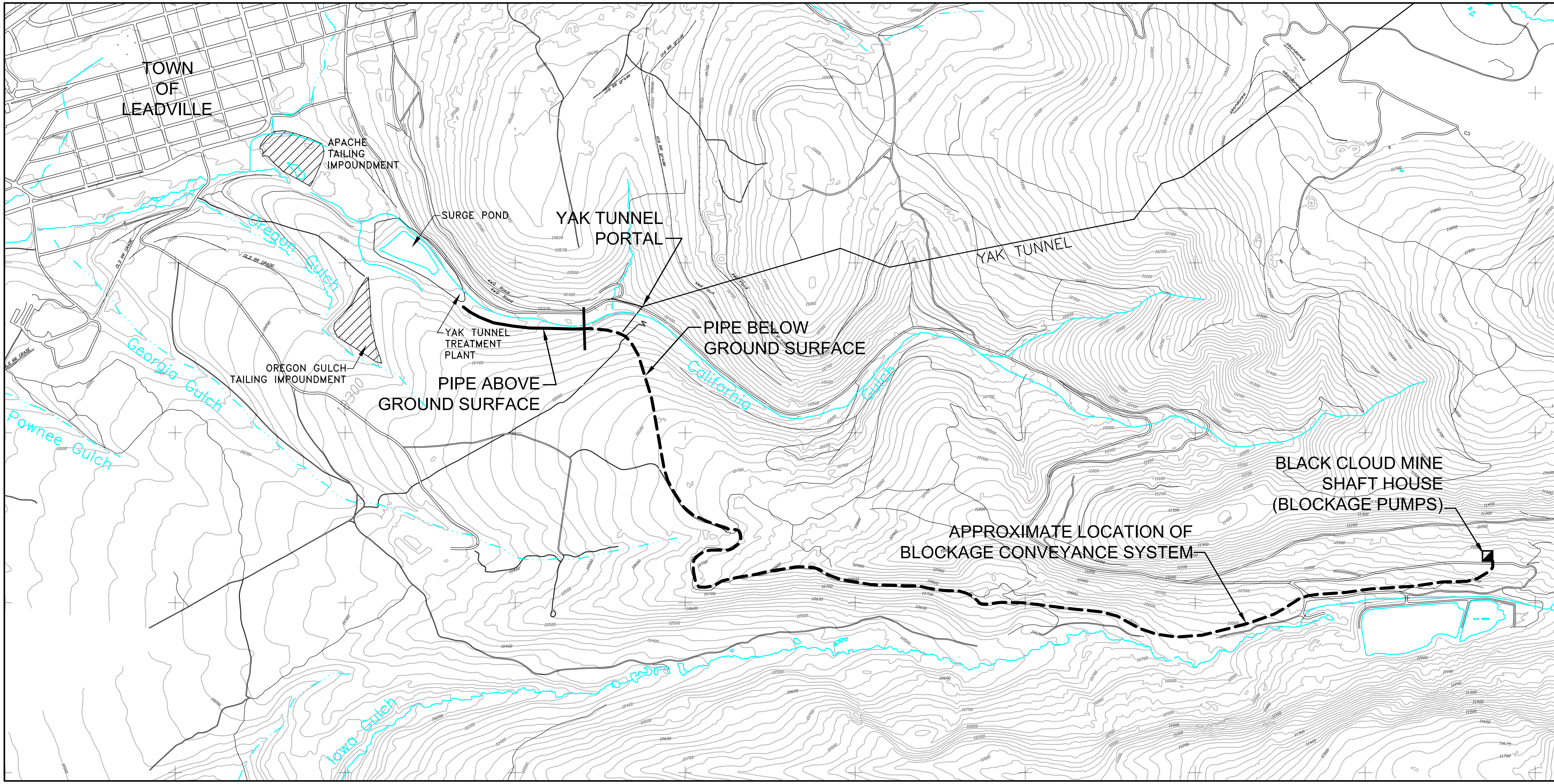

FIGURE 7
BLOCKAGE CONVEYANCE SYSTEM

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Date: MAY 2008
Project: 180885/37
File: PLAN-001.DWG

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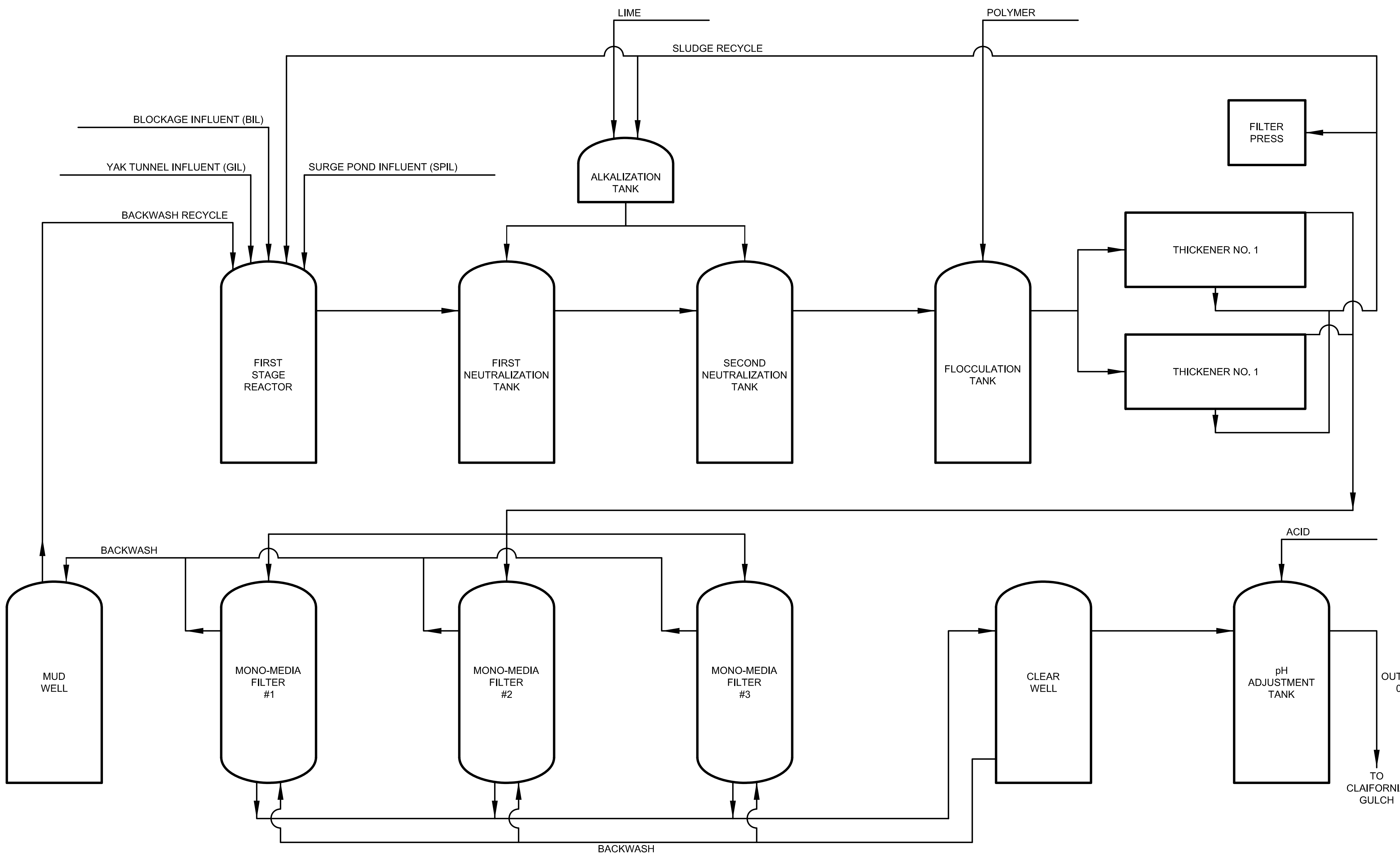

FIGURE 8
YAK WATER TREATMENT PLANT
TREATMENT PROCESSES

MFG, Inc.
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Date:	MAY 2008
Project:	180885/37
File:	SCHEM-02.dwg

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APPENDIX A

TO OU1 WORK PLAN

STANDARD OPERATING PROCEDURES

SOP Number	**Title**
1	Decontamination
2	Well Water Level Measurement
3	Field Instrument Calibration and Operation
4	Ground Water Monitoring Well Sampling
5	Surface Water Flow Measurement
6	Surface Water Sample Collection
7	Sample Handling, Documentation, and Analysis
8	Water Treatment Plant Sampling
9	Surge Pond Staff Gauge
10	Field QA/QC Samples
11	Water Level Measurement Using Pressure Transducers

O&M SOP-1

SOP Date: May 2008

DECONTAMINATION

1.0 INTRODUCTION AND TYPES OF CONTAMINATION

The purpose of this document is to define the standard procedure for decontamination associated with environmental investigation and remediation efforts for the California Gulch CERCLA Site. This procedure is intended to be used with other SOPs.

1.1 Site and/or Sample Cross-Contamination

The overall objective of multimedia sampling programs is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g., by contacting water with equipment previously contaminated at another sampling site). Trace quantities of these contaminant materials can thus be captured in a sample and lead to false positive analytical results and, ultimately, to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of personnel, sampling equipment (e.g., bailers, pumps, tubing, soil and sediment sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is therefore required at all Operable Units of the California Gulch site. To ensure that sampling cross-contamination is prevented, and that on site contaminants are not carried off site.

2.0 PROCEDURES

2.1 Equipment List

The following is a list of equipment that may be needed to perform decontamination:

- Brushes
- Wash tubs
- Buckets
- Scrapers
- Steam cleaner or high-pressure washer
- Paper towels
- Alconox detergent (or equivalent)
- Potable water
- Deionized or distilled water
- Garden type water sprayers
- Clean plastic sheeting and/or trash bags

2.2 Decontamination

2.2.1 Sampling Equipment

The following steps will be used to decontaminate sampling equipment that has been exposed to known or suspected hazardous materials (including reusable filter apparatus):

- Personnel will dress in suitable safety equipment to reduce personal exposure (e.g., latex gloves, safety glasses, etc.).
- Gross contamination on equipment will be scraped off at the sampling or construction site.
- Equipment that will not be damaged by water will be washed with an Alconox solution or low-sudsing detergent and potable water and scrubbed with a bristle brush or similar utensil (if possible). Equipment will be triple rinsed with potable water followed by a triple rinse with deionized or distilled water.

Following decontamination, equipment will be placed in a clean area, on or in clean plastic sheeting to prevent contact with contaminated soil. If the equipment is not used immediately, the equipment will be covered or wrapped in plastic sheeting or heavy duty trash bags to minimize potential airborne contamination.

2.2.2 Submersible Pumps

If submersible pumps are used they will be decontaminated between wells. The outside of the pump and hose will be tripled rinsed with deionized or distilled water. Deionized or distilled water will be pumped through the pump and hose. The volume of deionized or distilled water pumped through will be at a minimum equal to three times the volume of fluid that could be contained by the pump and hose.

2.2.3 Water Level Probes

Electric water level probes will be decontaminated by rinsing with deionized or distilled water or by wiping the probe during removal with paper towels wetted with deionized or distilled water. The water level probe will be placed in a plastic bag after decontamination.

2.2.4 Pressure Tranducer

Pressure transducers will be rinsed with deionized or distilled water prior to installation. When the transducer/datalogger is removed it will be wiped down using a clean rag to remove excess moisture and obvious rust or dirt as the equipment is being recovered from the well. Each datalogger and pressure transducer assembly is dedicated to a specific piezometer; therefore, the equipment does not need to be thoroughly decontaminated except when it may have contacted a contaminated surface during removal from the well.

2.2.5 Sensitive Equipment

Sensitive equipment that may be damaged by water will be carefully wiped clean using paper towels and detergent water or spray bottle and towel and rinsed with deionized or distilled water. Care will be taken to prevent any equipment damage.

2.2.6 Drilling and Heavy Equipment

Drilling and heavy equipment will be decontaminated at the decontamination area for large equipment near the Surge Pond. The following steps will be used to decontaminate drilling and heavy equipment:

- Personnel will dress in suitable safety equipment to reduce personal exposure (e.g., gloves, safety glasses or splash shields, etc.).
- Equipment showing gross contamination or having drill cuttings caked on will be scraped off with a flat-bladed scraper at the sampling or construction site.
- Equipment, such as drill rigs, augers, drill bits, and shovels will be sprayed with potable water by a high-pressure washer. Care should be taken to adequately clean the insides of the hollow-stem augers and backhoe buckets.

Following decontamination, drilling equipment will be placed on the clean drill rig and moved to a clean area. If the equipment is not used immediately, it should be stored in a designated clean area.

2.2.7 Equipment Leaving the Site

Vehicles used for nonintrusive activities shall be cleaned on an as needed basis. Cleaning will be required for very dirty vehicles which will be leaving the Leadville area. The cleaning shall take place at the decontamination area near the Surge Pond. On site construction equipment such as earth moving equipment, trucks, drilling rigs, backhoes, trailers, etc., will be pressure washed at the decontamination area near the Surge Pond before the equipment is removed from the site to limit off-site exposure to potential contaminants.

2.2.8 Wastewater

Used wash and rinse solutions may be discharged to the ground at the sampling site

2.2.9 Other Wastes

Solid wastes such as paper towels and used filters will be sealed in plastic garbage bags and disposed of in a sanitary landfill.

2.3 Documentation

Sampling personnel will be responsible for documenting the decontamination of sampling and drilling equipment. The documentation will be recorded with waterproof ink in the sampler's field notebook with consecutively numbered pages. The information entered in the field book concerning decontamination should include the following:

- Decontamination personnel
- Date
- Decontamination observations

O&M SOP-2

SOP Date: May 2008

WELL WATER LEVEL MEASUREMENT

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for measuring water levels in wells for California Gulch CERCLA Site. This procedure describes equipment and field procedures necessary to collect water level measurements. This procedure is intended to be used together with other SOPs. SOP No. 1 describes decontamination procedures which are applicable to this SOP.

2.0 WATER LEVEL MEASUREMENT PROCEDURES

2.1 Equipment List

The equipment necessary to measure water levels includes:

- Electric water level indicator capable of producing measurements to a precision of 0.01 ft
- Field data sheets
- Field notebook
- Sprayer filled with deionized or distilled water
- Appropriate health and safety equipment

2.2 Measurement Procedures

This section gives the sequence of events to follow when measuring water levels.

- Appropriate health and safety equipment, as described in the Health and Safety Plan, should be worn during well opening, well measurement, and decontamination.
- Before any measurement is taken, the water level probe shall be decontaminated. Decontamination procedures are discussed in SOP #1 and Section 2.3 of this SOP.
- Test the water level probe to verify that it is working properly. Push the circuit test button to verify that the light/buzzer is working. This button tests only the light/buzzer. Dip the water level probe into water to verify that the water level probe is working properly. Note that deionized or distilled water, due to its low conductivity, will not trigger a response.
- Unlock and open the well. Follow all health and safety procedures and, if necessary, let the well vent any gases that may be present in the well casing.
- After opening the well cover, locate the measuring point for water level measurements. The measuring point for the water level is usually the top of the polyvinyl chloride (PVC) well casing or top of the PVC drop pipe, not the top of the protective casing. If not already marked and described, the measurement should be taken either from the point where the PVC casing elevation was measured or from

the north side of the PVC casing, if possible. The point should be marked and described for easy identification.

- To measure the static water level, lower the water level probe into the well until the buzzer/light indicates that the probe tip has contacted water. By raising and lowering the water level probe and adjusting the sensitivity to indicate when the probe is contacting the water, the depth to water shall be measured to the nearest 0.01 foot. Record the water level depth in the field logbook or field data sheet. Then recheck the measurement before removing the water level probe from the well. Compare the most recent measurement with past measurements and verify that the new measurement is reasonable before leaving the well. If the measurement does not seem reasonable, measure the water level again.
- If the well is dry, record the maximum depth measured (e.g., dry to 85 feet).
- When raising or lowering the water level probe from the well, exercise great care to avoid pulling the probe wire over the well casing or the protective casing. Even PVC pipe can damage the water level probe and connecting cable if they are not handled properly.
- Section 2.4 describes the documentation required. If measurements are taken over a several-day period, the date and time of each measurement should be clearly indicated in the field book or on the water sampling forms.

2.3 Decontamination

The water level indicator must be decontaminated before using, between wells, and at the conclusion of measurements. The probe will be decontaminated according to the procedure for decontamination of sampling equipment described in SOP #1. Electric water level probes will be decontaminated by rinsing with deionized or distilled water or by wiping the probe during removal with paper towels wetted with deionized or distilled water. The water level probe will be placed in a plastic bag after decontamination. Probe decontamination can be completed at the wells.

2.4 Documentation

Documentation necessary for performing water level monitoring shall be recorded in the field logbook or on field data sheets (as shown in SOP No. 3 and only used if the wells are also to be sampled) and shall include, as appropriate:

- Personnel who performed the measurement
- Date
- Time
- Well number
- Depth to water from the measurement point
- Description of the measurement point location for the well (if different from previous measurement point)
- Well probe serial/identification number
- All calculations performed.

The field logbook or field data sheets used during water level measurement activities shall include any other observations made while measuring water levels. The pages of the field book or the field data sheets shall be legible, signed, and dated.

3.0 CALIBRATION

The length of the water level measurement probe cord will be calibrated when there is reason to suspect that the cord may have been stretched or damaged. The calibration check consists of laying out 100 ft tape next to 100 ft of the probe cord. Note any measurement discrepancies between the two at 2-ft intervals.

The procedures followed during any calibration and verification of equipment shall be documented in the field notebook along with any calculations. If a correction is required, the probe will be tagged to indicate the correction.

O&M SOP-3

SOP Date: May 2008

FIELD INSTRUMENT CALIBRATION AND OPERATION

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for calibrating/checking pH, conductivity, and turbidity meters used to measure field parameters for the California Gulch CERCLA Site. This procedure is intended to be used together with other SOPs. SOP No. 1 describes decontamination procedures which are applicable to this SOP.

2.0 FIELD METER CALIBRATION AND MEASUREMENT

Generic operational procedures are presented in this SOP. Instrument specific manufacturer's operation manuals should be referred to for more detailed instructions for the operation of any instrument.

2.1 pH Meter

The pH meter shall be calibrated each day before use for sample collection. The pH meters used at the treatment plant (both inline and during routine monitoring) will be checked (calibration check) daily and calibrated as needed. Calibration and operation of the pH meter shall be performed according to the manufacturer's specific instructions. In general, calibration is done by adjusting the meter with standard buffers that bracket the expected pH of the field water. Although the procedures described in this section are generic, they were generally written for Hach Company SensION ph meters.

2.1.1 Required pH Measurement Equipment

Use the following apparatus and supplies for measuring pH in the field:

- Portable pH meter
- Spare pH probe
- pH electrode storage solution
- Extra batteries
- Beakers
- Buffer solutions of pH 4, 7, and 10
- Deionized or distilled water
- Wash bottle
- Kimwipes® or equivalent
- Calibration Data Sheet.

Determine the pH from a water sample as soon as possible after collecting it. Determine the pH by the electrometric method using standard buffer solutions for calibration. The electrometric method is the preferred method because of its greater accuracy and ease of measurement.

Either a glass electrode and a reference electrode, or a combination electrode, which combines the glass membrane electrode and the reference electrode, shall be used.

The pH meter shall automatically compensate for temperature and be capable of calibration with a three-point (using three buffers) slope adjustment method. The meter shall have a precision of at least 0.05 pH units.

2.1.2 pH Meter Calibration Procedures

Before collecting samples, calibrate the pH meter in accordance with the manufacturer's instructions using calibration solutions. The field sampling technician shall record all pH measurement data, including calibration dates and times, readings, the meter number, and sample temperatures on a Calibration Data Sheet.

The field sampling technician shall be familiar with the meter and shall follow the manufacturer's instructions for calibrating and using the meter. Check the pH calibration immediately after calibration and at the end of the day against an appropriate buffer. Thoroughly document all calibration checks, including the buffer readings and temperatures, on the Calibration Data Sheet. The field sampling technician shall do the following when calibrating the meter according to the manufacturer's procedures:

- Condition pH electrodes by soaking them for at least one hour in pH electrode storage solution. pH electrodes that have been properly stored in pH electrode storage solution do not need to be conditioned.
- Buffer solutions of 4, 7, and 10 will be used for calibration and an appropriate buffer solution for calibration checks. Use aliquots of the buffer solutions once and then discard the aliquots.
- Before immersing the probe(s) into the buffer or sample, rinse the probe with deionized or distilled water and blot it dry with clean Kimwipes® (or equivalent) and then rinse the probe with the buffer or sample. Protect the glass tip of the probe from abrasion and scratching.
- Calibrate the meter with three buffer solutions (three-point slope adjustment).
- Turn the instrument on and immerse the probe into the 7 pH buffer and allow to equilibrate until the display lock is enabled. Press the **CAL** button, **Standard** and 1 will be displayed and then press the **READ/ENTER** button. When the reading has stabilized, the standard number will change to **2**. Remove the probe from the 7 pH buffer and rinse with deionized water. Place the probe into the 10 pH buffer and press **READ/ENTER**. When the reading has stabilized the standard number will change to **3**. Remove the probe from the 10 pH buffer and rinse with deionized water. Place the probe into the 4 pH buffer and press **READ/ENTER**. When the reading has stabilized the **Store** and **?** will appear. To save the calibration and return to the reading mode, press **ENTER**. To review and document the calibration data on the Field Parameter Instrument Calibration Data Sheet press the **REVIEW** key. The display will show the standard number, standard pH, and temperature. Press the **UP** arrow once. The meter will continue to scroll through the standard information with each press of the up arrow key until the slope information is

displayed. Record the calibration data on the Calibration Data Sheet. Press **EXIT** to exit the Cal Review mode.

- Immediately after calibration perform a calibration check by measuring at least the 7 pH buffer or other appropriate buffer and recording the values on the Calibration Data Sheet. Other standard may need to be checked depending on the water to be measured. If the calibration check buffer varies by more than 0.2 pH units then the meter shall be recalibrated.
- If the calibrated slope of the pH meter deviates significantly from its theoretical value, test for a potentially defective electrode or contaminated buffer solution.
- Slow instrument response (long time to stabilize) may indicate that the pH probe should be replaced.
- Always use the same electrode for measurements that was used for calibration. Recalibrate the meter if the electrode is replaced or the batteries are changed.

2.1.3 pH Measurement

The sampler shall measure pH as follows:

1. If the pH is measured in a container, rinse the sample container with deionized water and then rinse it three times with the sample water prior to measurement. Rinse the pH probe with deionized water and, if possible, blot the probe dry with clean Kimwipes® or equivalent then rinse the pH probe with sample water. Be sure to protect the fragile glass bulb at the end of the probe from damage.
2. Immerse the electrode in the water, allow the pH reading to stabilize, and monitor the drift of the instrument. Do not immerse the electrode above the top of the pH probe. When the pH reading stabilizes (i.e., the meter beeps and the display lock is enabled), record the temperature to the nearest 0.1 °C and the pH reading to the nearest 0.01 unit.
3. Between measurements, store the electrode in Hach pH electrode storage solution or equivalent solution, if possible, or put a cotton swab soaked in electrode solution in the protective cap of the electrode.
4. Measure the pH of samples within a short period of time after sampling and on a separate aliquot of the sample.
5. Store the electrode on a short-term basis (between measurements/up to one week) in the Hach pH electrode storage solution or place a cotton swab that has been soaked in pH electrode storage solution in the pH probe protective cap. Do not store the electrode in deionized water, as this will shorten the electrode life.
6. Avoid prolonged exposure of the pH meter and probe to sunlight.

2.2 Conductivity Meter

The conductivity meter shall be calibrated each day before use for sample collection. The conductivity meters used at the treatment plant (both inline and during routine monitoring) will be checked (calibration check) daily and calibrated as needed. Calibration and operation of the conductivity meter shall be performed according to the manufacturer's specific instructions. In general, a single point calibration (near midrange of expected values) is performed and then the calibration is checked by checking with standards that bracket the expected value of the sample water. Although the procedures described in this section are generic, they were generally written for Hach Company sensION conductivity meters.

Electrical conductivity, or specific conductance, is the ability of water to conduct an electric current and depends on the concentration of ions in solution. The relationship between conductivity and the concentration of dissolved solids is approximately linear for most natural waters. Changes in this relationship indicate changes in the proportions of different salts and, therefore, changes in the sources of dissolved substances that enter the water body.

For measuring conductivity in the field, the meter shall have an automatic temperature compensator and shall display conductivity directly in units of microsiemens per centimeter (µS/cm) or in millisiemens per centimeter (mS/cm) corrected to a temperature of 25 °C.

Electrical conductivity shall not be measured on a sample that was first used to measure pH. Potassium or silver chloride that diffuses from the pH probe can alter the conductivity of the sample.

2.2.1 Required Conductivity Measurement Equipment

Use the following apparatus and supplies for measuring conductivity in the field:

- Conductivity meter
- Extra batteries
- Calibration solutions (one near the midpoint and two which bracket expected sample values)
- Deionized or distilled water
- Wash bottle
- Kimwipes® or equivalent
- Beakers
- Calibration Data Sheet

2.2.2 Conductivity Meter Calibration

Before collecting samples, calibrate the conductivity meter using calibration solutions in accordance with the manufacturer's instructions. The sampler shall record all conductivity measurement data, including calibration dates, readings, the meter number, and sample temperatures on a Calibration Data Sheet.

Reagent-grade potassium chloride (KCl) or other equivalent solutions are universally used as reference solutions to calibrate conductivity equipment. The reference solutions are also used to check the accuracy of the meter. The conductivity of the reference solutions that are used to calibrate the meter should bracket the expected range of the conductivity of the water samples. Commercially prepared calibration standards are available from laboratory suppliers at many standard concentrations.

The sampler shall calibrate the meter as follows:

1. Calibrate the meter according to the manufacturer's instructions.
2. Verify that the automatic temperature compensation is on by looking for the thermometer icon. If **Off** is displayed next to the thermometer icon then the automatic temperature compensation is off. If **Off** is displayed then refer to the owner's manual to turn the automatic temperature compensation on.
3. Before immersing the probe(s) into the standard, rinse the probe with deionized or distilled water and blot it dry with clean Kimwipes® (or equivalent) and then rinse the probe with the standard.
4. Immerse the probe in the midpoint standard solution. Agitate the probe to dislodge bubbles in the cell. Avoid resting the probe on the bottom or side of the container.
5. Press **CAL**. The last calibration value will appear. Refer to the owner's manual to initially set the calibration value to the appropriate value then subsequent calibrations will display the value automatically. Press **ENTER** when the reading is stable the calibration is automatically stored and the instrument returns to the reading mode. Note the calibration data on the Calibration Data Sheet.
6. Check the calibration by measuring the end point standards and recording the check data on the Calibration Data Sheet. If the check values are not within 10 percent of the standard value then the instrument must be recalibrated.
7. An end of day calibration check shall be made by measuring the end point standards and recording the check data on the Calibration Data Sheet. If the check values are not within 10 percent of the standard value then it must be noted on the Ground Water Sampling Data Sheets for the samples collected that day.

2.2.3 Conductivity Measurement

Measure conductivity immediately after a sample is collected. Record conductivity readings to the nearest 1 µS/cm (for samples with conductivities less than 2,000 µS/cm) or 0.01 mS/cm (for samples with conductivities greater than 2.00 mS/cm), corrected to 25°C.

The sampler shall measure conductivity as follows:

1. Rinse the probe with deionized water and blot the probe dry with clean Kimwipes® or equivalent, without wiping the plating on the cell. Rinse the probe with sample water.
2. Insert the probe into the sample solution. Immerse the tip to or beyond the vent holes and agitate the probe vertically. Make sure that air bubbles are not trapped near the temperature sensor. Avoid resting the probe on the bottom or side of the container. Allow the reading to stabilize before recording measurements. Record the conductivity and temperature of the sample.
3. Verify that the correct units (µS/cm) or mS/cm) are indicated on the Ground Water Sampling Data Sheet.

4. During normal use, rinse the probe thoroughly with deionized water between measurements to minimize the buildup of interfering substances on the probe element.
5. Avoid prolonged exposure of the probe to sunlight.

2.2.4 Field Calibration Checks

In order to determine if the pH meter and conductivity meter measurements are accurate, the pH meter and conductivity meter calibrations shall be checked against a known standard immediately after calibration and at the end of the day. If the conductivity meter reading differs by more than 10 percent from the check standard, the conductivity meter shall be re-calibrated. If the pH reading differs by more than 0.2 pH units from the check standard, the pH meter shall be re-calibrated. All check standard readings and re-calibrations shall be recorded in the Calibration Data Sheet.

3.0 TURBIDITY METER CALIBRATION AND MEASUREMENT

One of the most sensitive and, therefore, the most representative field parameter measured during ground water sample collection is turbidity. Turbidity is measured in the field with the Hach Portable Turbidimeter Model 2100P. The procedure presented below is generic and the Hach Portable Turbidimeter Model 2100P Manual should be consulted for more detailed procedures.

3.1 Turbidity Measurement Equipment

Use the following apparatus and supplies for measuring turbidity in the field:

- Hach Portable Turbidimeter Model 2100P
- Measurement cells
- Extra battery
- Gelex standards (dedicated to the specific meter)
- Silicone oil and cloth
- Deionized water
- Wash bottle
- Liquinox solution
- Kimwipes
- Beakers.

3.2 Turbidity Meter Calibration and Measurements

Calibrate the turbidimeter in the laboratory as necessary before mobilizing to the field. Once in the field, check the calibration by measuring the Gelex standards. Gelex standards are used as a calibration check only and are not to be used for instrument calibration. The field sampling team shall record calibration checks, dates, and the SMI meter number on a Calibration Data Sheet or in the field book.

Note the following operational considerations:

- Avoid prolonged exposure to ultraviolet light and sunlight.
- Do not hold the instrument during measurements; place the instrument on a flat, steady surface.
- Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.
- Handle measurement cells only by the top to minimize dirt, scratches, and fingerprints in the light path.
- Always cap the sample cell to prevent spillage of sample into the instrument.
- Always orient the sample cell and Gelex standards in the same direction, i.e., diamond shaped mark to the front of the instrument.
- Always close the sample compartment lid during measurement and storage.
- When oiling the sample cells, use only a thin coat of oil. Do not use excessive amounts of oil.

The sampler shall measure turbidity as follows:

1. Thoroughly check the meter, including the battery, in the laboratory before taking it to the field.
2. Measure and record on the Calibration Data Sheet the turbidity of the Gelex standards and compare it to its value.
3. Clean the sample cell.
4. Fill the sample cell with sample.
5. Clean and oil the sample cell.
6. Place the cell in the meter.
7. Select the range.
8. Signal average the sample (if necessary).
9. Read and record the turbidity to 0.01, 0.1, or 1.0 NTU, depending on the range of the sample.
10. Empty and clean the sample cell.

4.0 DOCUMENTATION

Record all calibration and calibration check data on the Calibration Data Sheet or in the field book.

APPENDIX A
CALIBRATION DATA SHEET

CALIBRATION DATA SHEEET

Date: ______________________Time: ________________ Personnel: ________________________

pH Meter Calibration pH Meter Number: _________________________________

Buffer:__7___Measured Value:________________________Temperature________________________°C

Buffer:__4___Measured Value:________________________Temperature:_______________________°C

Buffer:__10__Measured Value: Temperature:_______________________°C

Slope: _________________________

pH Meter Calibration Check (Immediately After Calibration)

Buffer:______Measured Value:________________________Temperature:______________________°C

Buffer:______Measured Value:________________________Temperature:______________________°C

Buffer:______Measured Value:________________________Temperature:______________________°C

pH Meter Calibration Check (At End of Day) Time: :____________________________

Buffer:______Measured Value:________________________Temperature:______________________°C

Buffer:______Measured Value:________________________Temperature:______________________°C

Buffer:______Measured Value:________________________Temperature:______________________°C

Conductivity Meter Calibration Conductivity Meter Number:____________________

Standard:___________µS/cm Measured Value:____________µS/cm Temperature:____________°C

Conductivity Meter Calibration Check (Immediately After Calibration)

Standard:___________µS/cm Measured Value:____________µS/cm Temperature:____________°C

Standard:___________µS/cm Measured Value:____________µS/cm Temperature:____________°C

Conductivity Meter Calibration Check (At End of Day) Time: ________________________

Standard:___________µS/cm Measured Value:____________µS/cm Temperature:____________°C

Turbidity Meter Check Turbidity Meter Number:______________________

Gelex Standard Value:______________________ Gelex Standard Reading: _____________________

Gelex Standard Value:______________________ Gelex Standard Reading: _____________________

Comments:

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O&M SOP-4

SOP Date: May 2008

GROUNDWATER MONITORING WELL SAMPLING

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for collecting groundwater samples from wells for the California Gulch CERCLA Site. This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect groundwater samples from wells. The sample locations and frequency of collection are specified in the QAPP.

This procedure is intended to be used together with several other SOPs including:

- SOP 1 Decontamination
- SOP 2 Monitoring Well Water Level Measurement
- SOP 3 Field Instrument Calibration and Operation
- SOP 7 Sample Handling, Documentation, and Analysis
- SOP 10 Field QA/QC Samples

2.0 WATER SAMPLING PROCEDURES

2.1 Equipment List

Sample bottles, preservatives, sample labels will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems. Sample bottles can be either pre-preserved or preservatives can be added in the field.

Equipment that may be used during well evacuation:

- Well keys
- Electronic water level probe
- Assorted tools (knife, screwdriver, etc.)
- PVC, Teflon, or stainless-steel bailer (bottom filling)
- PVC hand pump
- Nylon or polypropolene rope
- Bailer tripod
- PVC pump discharge hose
- Gas-powered electric generator
- Stainless-steel submersible pump
- pH meter (with automatic temperature compensation)
- Specific conductivity meter
- Plastic squeeze bottle filled with deionized water
- Polyethylene or glass container (for field parameter measurements)

- Chemical-free paper towels or Kimwipes
- Calculator
- Field notebook
- Waterproof pen
- Plastic sheeting (for placing around well)
- Appropriate health and safety equipment

Equipment that may be used during well sampling:

- Electronic water level measurement probe
- PVC, Teflon, or stainless-steel bailers (bottom filling)
- Stainless-steel submersible pump
- PVC pump discharge hose
- Electric generator
- Nylon or polypropolene rope or twine
- Bailer tripod
- pH meter (with automatic temperature compensation)
- Specific conductivity meter
- Plastic squeeze bottle filled with deionized water
- Sample bottles
- Dedicated jug for holding sample for filtering
- Cooler with ice
- Polyethylene or glass jar for field measurement samples
- Sample labels

Equipment used during sample filtration:

- Disposable filterware with 0.45-micron filter
- Hand pump or peristaltic pump
- Tygon or silicon tubing (2- to 4 ft lengths)

Equipment used during decontamination:

- Deionized or distilled water
- Decontamination buckets/pails
- Paper towels
- Plastic brushes
- Sprayers

2.2 Sampling Procedures

This section gives the step-by-step procedures for collecting samples in the field. Observations made during sample collection should be recorded in the field notebook and field data sheet as specified in Section 2.4 of this SOP.

2.2.1 Decontaminate Equipment

Before any evacuation or sampling begins, all well probes, bailers, and other sampling devices shall be decontaminated. If dedicated equipment is used, it should be rinsed with deionized water. Dedicated downhole pumps will not be decontaminated. A discussion of equipment and personnel decontamination is contained in SOP No. 1, Decontamination, and in the site Health and Safety Plan.

2.2.2 Instrument Calibration

Electronic equipment used during sampling includes a pH meter with temperature scale, a conductivity meter. and turbidity meter. Before going into the field, the sampler shall verify that all of these are operating properly. The pH and conductivity meters require calibration and calibration checks every day prior to use. The turbidity meter requires a calibration check by reading measurements cells of a known value. Calibration times and readings will be recorded in a notebook and/or on Calibration Data Sheet, which are to be kept by the field sampler. Specific instructions pH, conductivity, and turbidity instruments are given in SOP 3.

2.2.3 Evacuate Well

The purpose of well purging is to remove stagnant water from the well to obtain representative water from the geologic formation being sampled while minimizing disturbance to the collected samples. Before a sample is taken, the well will be purged until a minimum of three well casing volumes have been removed and field parameters have stabilized, or until a maximum of five well volumes have been removed. Purging will be considered completed if the well is pumped or bailed dry. A well should be pumped at a rate no faster than approximately 1 gallon per minute if it has a tendency to dry up prior to evacuating three casing volumes. Evacuated well water may be disposed of at the well site in a manner that does not cause runoff.

Before well purging begins, the following procedures are to be performed at each well:

- Note the condition of the outer well casing, concrete well pad, protective posts (if present), and any other unusual conditions in the area around the well.
- If bailing place clean plastic sheeting around the well.
- Open the well.
- Note the condition of the inner well cap and casing.
- Following SOP 2 measure (to nearest 0.01 foot) and record depth of static water level from the measuring point on the well casing and indicate time. Record what the measuring point is (i.e., notch on north side, top of PVC well casing).
- Calculate volume of water in the well casing in gallons based on feet of water and casing diameter. (See Section 2.4.3 for calculation of volumes.)
- From the above calculation, calculate the three casing volumes to be evacuated.
- If a pressure transducer for water level measurements is installed in the well, download data from the data logger as per SOP 12 and make any corrections to the reference level using the recorded depth of static water level obtained previously Remove pressure transducer from well, winding the transducer cable on a steel or plastic reel. If a reel is not available, place a clean, plastic sheet on the ground and wind the cable on top of the sheet.

- Obtain an initial sample (which is not retained) from the bailer or purge pump for field measurements (temperature, conductivity, and pH measurements) and observation of water quality.
- Evacuate three volumes of water in casing with a bailer or pump. Take temperature, specific conductance, and pH measurements after evacuation of each well volume to confirm that the water chemistry has stabilized. Generally, pH values within ±0.2 pH unit and conductivity and temperature readings within ±10 percent between consecutive readings indicate good stability of the water chemistry. If the chemistry is not stable, continue purging up to a maximum of five well volumes, measuring pH and specific conductance after each one half well volume.
- When evacuating a well using a pump, the pump intake should be placed:
  1. for low recovery wells (wells that can be pumped dry), place pump intake at bottom of screened interval.
  2. for high recovery wells (little drawdown with pumping), place pump at or slightly above the middle of the screened interval to ensure the removal of stagnant water from the well bore.
- If the well is bailed or pumped dry during evacuation, it can be assumed that the purpose of removing 3 well volumes of water has been accomplished, that is, removing all stagnant water that had prolonged contact with the well casing or air. If recovery is very slow, samples may be obtained as soon as sufficient water is available.

2.2.4 Obtain Water Samples

a. Obtain samples for chemical analysis within 2 hours after purging is completed, if possible. For slow recovering wells, the sample shall be collected immediately after a sufficient volume is available (water has recovered to screened interval). The water quality samples shall be taken from within the well screen interval.

b. The following sampling procedure is to be used at each well:
   1. Assemble decontaminated sampling equipment. If bailers are used, new nylon or polypropylene rope will be used for each well for each sampling event. Assemble the filtering apparatus.
   2. Make sure that sample labels have been filled out for each well.
   3. Lower the bailer slowly and gently into contact with the water in the well. Lower the bailer to the same depth in the well each time, within the screened interval. Retrieve the bailer smoothly and empty the water in a slow steady stream into the containers If submersible or bladder pumps are utilized to collect samples, start the pump and fill the sample bottles as described below.

c. a) Triple rinse the sample containers with sample water and then fill the sample bottles. If not enough sample water is available to perform the triple rinse, then at a minimum a single rinse will be performed and will be recorded in the field logbook and/or data sheet. Cap the sample containers quickly. If sample bottles are pre-preserved, fill the sample bottles without rinsing. Add preservative if the bottle is not pre-preserved. Do not allow the sample containers with preservatives to overflow.

See Section 2.2.5 for details on field filtering.

d) Slowly pour an unfiltered portion into the sample container for field parameter (pH, specific conductance, temperature, and turbidity) analyses and perform the in-field analyses and record.

e) Place samples on ice in a cooler.

5. Record time of sampling.
6. Replace and lock well cap.
7. Complete field documentation.

f) Replace the pressure transducer, if applicable, and check for normal operation, as per SOP12.

2.2.5 Filtering Samples

Samples for metals analyses will be filtered during the field sampling event by using a disposable filter apparatus and peristaltic or hand vacuum pump.

The following procedure is to be used for filtering:

- Assemble filter device according to manufacturer's instructions.
- Prior to the collection of aliquots, flush the filter with approximately 100 to 200 milliliters of groundwater. Filter sample either by pouring sample in the top portion of filter unit or pumping through an in line filter using a peristaltic pump. Sample may also be filtered by attaching the in-line filter to the submersible pump discharge.
- Triple rinse the sample containers with filtered sample water and then fill the sample bottles. If not enough sample water is available to perform the triple rinse, then at a minimum a single rinse will be performed and will be recorded in the field logbook and/or data sheet. Cap the sample containers quickly. If sample bottles are pre-preserved, fill the sample bottles without rinsing. Add preservative if the bottle is not pre-preserved. Do not allow the sample containers with preservatives to overflow.
- Place the used filter membrane or disposable filter equipment in a Ziploc® bag for disposal with the personal protective equipment.
- Any reusable filtering equipment will be decontaminated in accordance with SOP No. 1.

2.2.6 Field Quality Assurance/Quality Control Procedures and Samples

The well sampling order will be dependent on expected levels of contamination in each well, if known, and will be determined prior to sampling. Quality assurance/quality control (QA/QC) samples will be collected during groundwater sampling as specified in SOP 11.

2.3 Sample Handling

Sample containers and preservatives are specified in SOP No. 7, Sample Handling, Documentation and Analysis. Samples will be labeled and handled as described in SOP No. 7. The parameters for analysis are specified in the Quality Assurance Project Plan (QAPP).

2.4 Documentation

2.4.1 Groundwater Data Sheet

A groundwater data sheet for groundwater samples (Appendix A) will be completed at each sampling location. The data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable (NA). The information on the data sheet includes the following:

- Well number
- Date and time of sampling
- Person performing sampling
- Depth to water before sampling
- Volume of water evacuated before sampling
- Conductivity, temperature, and pH during evacuation (note number of well volumes) Time samples are obtained
- Number of samples taken
- Sample identification number(s)
- Preservation of samples
- QC samples taken (if any)
- How the samples were collected (i.e., bailer, pump, etc.)

2.4.2 Field Notes

Field notes shall be kept in a bound field book. The following information will be recorded using waterproof ink:

- Names of personnel
- Weather conditions
- Date and time of sampling
- Location and well number
- Condition of the well
- Decontamination information
- Initial static water level and total well depth
- Calculations (e.g., calculation of evacuated volume)
- Calibration information
- Sample methods, or reference to the appropriate SOP

2.4.3 Well Volume Calculations

The following equation shall be used to calculate the volume of water to be removed during well evacuation.

For 2 inch well:

Evacuation Volume [gal] = (Total Depth [ft] - Water Level Depth [ft]) x 0.1632 gal/ft

	=	gallons/well casing volume
For 4-inch well:		
Evacuation Volume [gal]	=	(Total Depth [ft] - Water Level Depth [ft]) x 0.6528 gal/ft
	=	gallons/well casing volume
For 6-inch well:		
Evacuation Volume [gal]	=	(Total Depth [ft] - Water Level Depth [ft]) x 1.4688 gal/ft
	=	gallons/well casing volume

Multiply the volume of one well casing volume by 3 to obtain the minimum volume of water to be evacuated.

APPENDIX A
GROUNDWATER DATA SHEET

GROUNDWATER DATA SHEET

IDENTIFICATION

Sample Location_____________________________ Date _________ Time ________Page___of_____

Sample Control Number____________________________ Samplers: ___________________________

WEATHER CONDITIONS

Ambient Air Temperature: ____ °C ☐ _____ °F ☐ Not Measured? ☐

Precipitation: None ☐ Rain ☐ Snow ☐ Heavy ☐ Moderate ☐ Light ☐ Sunny ☐ Partly Cloudy ☐

WELL MEASUREMENTS (Measurements made from top of PVC casing)

Depth to Static Water:______________feet Total Depth of Well:________ feet Feet of water:_________

2-inch = 0.163 gal/ft 4-inch = 0.65 gal/ft 6-inch = 1.47 gal/ft

1 Casing Volume:_________________ gallons 3 Casing Volumes:_____________ gallons

Depth Pump Installed:_________ feet Volume water purged_______________________ Gallons

Well purged with: ______________________________

FIELD PARAMETER MEASUREMENTS DURING PURGING

Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp.° °C ☐ °F ☐	Turbidity (visual estimate)	Comments

Final Sample Parameters

Sample Date	Sample Time	Volume (gallons)	pH	Cond. (µS/cm)	Temp. °C ☐ °F ☐	Turbidity (NTU)

Was a duplicate sample collected? Yes ☐ No ☐ (sample control number______________________)

Was a field blank collected? Yes ☐ No ☐ (sample control number______________________)

Was a rinsate sample collected? Yes ☐ No ☐ (sample control number______________________)

Notes: ____

____

O&M SOP-5

SOP Date: May 2008

SURFACE WATER FLOW MEASUREMENT

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the Standard Operating Procedures (SOP) for measuring surface water discharge in streams and ditches at the California Gulch CERCLA Site (CGS) in Leadville, Colorado. Discharge is defined as the volume rate of flow of water, including any substances suspended or dissolved in the water. Discharge will be expressed in cubic feet per second (cfs) or gallons per minute (gpm). A complete discussion of all available flow measurement techniques and the theory behind them is beyond the scope of this text (see UGSG Water-Supply Paper 2175). This SOP outlines the three methods for measuring flow at CGS: (1) permanently installed or portable flumes, (2) the velocity-area method using Price AA, pygmy, or Marsh-McBirney meters, or (3) the volumetric method.

Because of the dynamic nature of surface water, flow measurement by the methods described in this document may, on occasion, be impossible at some sites. If unmeasurable flow conditions exist at any of the surface water sites, the field team will attempt to measure flow at a point upstream or downstream of the site and will note this point relative to the marked data collection point. Whether or not a measurement is made, the team will note the conditions that inhibited accurate flow measurement.

The discharge measurement method to be used at each site will be described in the field notes. Each of these methods will be presented in the following format:

- Method name
- Required measurement conditions
- Equipment
- Maintenance and calibration procedures
- Field procedures
- Discharge calculations

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The project manager or task leader is responsible for assigning project staff to measure discharge at CGS. The project manager is also responsible for assuring that this and any other appropriate procedures are followed by all project personnel. The project staff assigned to measure discharge are responsible for completing their measurements according to this SOP.

Only qualified personnel will be allowed to perform these procedures. Qualifications are based on education, previous experience, and on-the-job training and supervision by another qualified person.

3.0 PROCEDURES

This section describes the three methods that will be used to measure discharge.

If none of these three methods can be used to measure discharge at a particular sample location, then other methods may be selected and added as addenda to this SOP; or, the measurement point will be evaluated in terms of whether it can either be relocated to a point which permits discharge measurement or whether the point should be eliminated. Discharge measurements should be recorded on Surface Water Data Sheet or on the Discharge Measurement Form, both provided in Appendix A.

3.1 Velocity-Area Method

Surface flow in stream channels and ditches that lack permanent flumes can be measured using a current meter or velocity-area method.

3.1.1 Marsh-McBirney Velocity Meter

The Marsh-McBirney velocity meter is preferred for measuring flow velocity at CGS.

Portable Marsh-McBirney meters are a type of current meter that may be used in the velocity-area flow measurement. Either Model 201D or Model 2000 will be acceptable for the required gauging. The Marsh-McBirney meters measure flow velocity using the Faraday principle which states that as a conductor moves through and cuts the lines of a magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field.

The selector switch of the Model 201D has five positions, these positions are OFF, CAL, FT/SEC, M/SEC and KNOTS. To check for electronics failure or discharged batteries, the selector is first switched to the CAL position and the time constant switch to 2. If this is not the case, change the batteries and check CAL again. The time constant switch is used to help stabilize the velocity readings. General procedures are to begin with the smallest time constant and increase if the readout velocity does not stabilize.

The sensor on the Marsh-McBirney meter can be connected to the universal sensor mount on the top-setting wading rod and used to determine flows using either the six-tenths depth method or the two-tenths and eight-tenths depths method. The minimum flow depth at which an average velocity can be measured with the Marsh-McBirney meter set at six-tenths of total depth is approximately 0.18 feet. Velocities can be estimated in flows as shallow as 0.1 feet. The meter is capable of measuring velocities ranging from 0 to 20 feet per second.

3.1.2 Vertical Axis Current Meter

The vertical axis current meter is acceptable when using the velocity-area method for the following reasons:

- This meter operates in lower velocities than the horizontal-axis meter
- Bearings are well-protected from silty water

- Rotor can be repaired in the field without adversely affecting the measurement
- Single rotor serves for the entire range of velocities

A common type of vertical axis current meter is the price current meter, type AA or Marsh-McBirney.

In addition to the type AA meters, the U.S. Geological Survey and others use a Price pygmy meter in shallow depths. The pygmy meter is scaled two-fifths as large as the standard meter and has neither a tailpiece nor a pentagear. The contact chamber is an integral part of the yoke of the meter. The pygmy meter makes one contact per revolution. The predominant flow conditions in channelized streams at CGS indicate that either the pygmy meter or the Price AA meter may be needed at particular sites, depending on the amount of runoff contributing to streamflow at the time.

Theoretical Considerations

The volume rate of flow of water, which is commonly called discharge (Q), is the product of multiplying the average velocity (V) times the total cross-sectional area (A):

$$Q = VA$$

where Q is the total discharge, V is the average velocity for the entire cross section, and A is the total cross-sectional area.

Any current meter measures velocity at a point. The velocity-area method of making discharge measurements at a cross section requires measurement of the mean velocity in multiple portions of the cross section at each of the selected verticals. These are taken at subsections of the cross section. A complete discussion of velocity observation methods is found in United States Geological Survey Water-Supply Paper 2175, Measurement and Computation of Streamflow: Volume 1 – Measurement of Stage and Discharge, Chapter 5. These methods have been found to accurately measure average velocities in the stream depths expected to be found at CGS surface water sites.

By dividing the stream width into subsections, total discharge becomes the total of discharges measured in each subsection. Individual point velocity (v) is measured at each subsection, and discharge becomes the sum of the products of each point velocity and cross-sectional area (a) of each subsection:

$$Q = \sum_{1}^{n} va$$

where Q is total discharge, v is point velocity, and a is the area of the subsection. A cross section is defined by depths at verticals 1, 2, 3, 4,...n. At each vertical, the average velocity is measured by a current meter.

The current meter measurements performed in channelized streams at CGS will be based on selecting subsections to contain approximately 10 percent or less of the total discharge. In general, depending on average depth and velocity distribution, a stream less than 2 feet wide will require no more than 8 to 10 subsections. A stream up to 4 feet wide will require about 10 to 12 subsections. Streams wider than 4 feet will require more subsections. Further, subsections need not be of identical width. For example, because velocities near banks are generally lower than velocities near the center of streams, these subsections may be wider than subsections near the center. Subsections will also be more closely spaced if a stream has an unusually deep portion in the cross section, or if velocities are higher than usual for the cross section. Velocity will be observed by current meter at each point for a period that ranges from 40 to 70 seconds.

The following table is to be used to guide the selection of the approximate number of subsections to be used based on stream width:

Table 1 Number of Subsections Based on Stream Width

Approximate Width (ft)	Approximate Number of Subsections	Approximate Distance between Subsections (ft)
<2	8 – 10	0.2 - 0.3
2 – 4	10 -12	0.3 - 0.4
4 – 10	12 – 15	0.4 - 0.7
10 – 20	15 – 20	0.7 - 1.0
>20	20 – 25	1.0 - 2.0

The stage of a stream is the height of the water surface above an established datum plane. The water-surface elevation referred to is some arbitrary gage datum is called the "gage height." Stage or gage height is to be measured and recorded in feet and hundredths of a foot.

Required Measurement Conditions

In order to make a velocity-area discharge measurement, the following conditions are required:

1. The stream must be channelized; that is, observable banks must channel the stream flow.
2. Depth must be greater than 0.2 foot across most of the cross section being measured.
3. The stream must have measurable velocity of at least 0.2 feet per second (fps) in most of the cross section, although the pygmy meter is capable of measuring velocity as low as 0.07 fps.

Conditions No. 2 and 3 can often be met in streams of very low discharge by conservatively modifying the stream channel to produce a narrower and slightly deeper cross section in order to meet measurement requirements. These modifications will include removal of aquatic growth or ice, moving large stones which impact velocity upstream or downstream of the cross section, and narrowing or deepening of the cross section. By rearranging small amounts of native rock or sand, the technician will produce a measurable cross section. When such modifications are made, great care will be exercised to avoid unnecessary movement of sediments. After clearing the cross section, allow the flow to stabilize before measurement begins.

Current meter measurements are best made by wading, if conditions permit. Wading measurements have a distinct advantage over measurements made from cableways or bridges in that it is usually possible to select the best of several available cross sections for the measurement. The type AA, Pygmy meter, or Marsh-McBirney is used for wading measurements. Table 2 lists the type of meter and velocity method to be used for wading measurements at various depths. A discussion of Table 2 follows the table.

Some departure from Table 2 is permissible. For example, if a type AA meter is being used in a measurement section that has most of its depth greater than 1.5 feet, the pygmy meter should not be substituted for a few depths that are less than 1.5 feet, or vice versa. The type AA meter should not typically be used in depths less than 1.25 feet. The Marsh-McBirney meter is appropriate for all depths deeper than 0.15 feet.

Table 2 Current Meter and Velocity Method for Various Depths (ft)

Depth (feet)	Meter*	Velocity Method (% of Depth)
1.5-2.5	Type AA	0.6
0.3-1.5	Pygmy	0.6
<0.3	Pygmy	0.5

* The Marsh-McBirney meter is appropriate for all depths deeper than 0.15 ft.

In the 0.6-depth, an observation of velocity made in the vertical at 0.6 of the depth below the surface is used as the mean velocity in the vertical. The 0.5-depth method will be used in very shallow stream conditions, with depths of less than 0.3 feet. This method requires that the meter be set at one-half the depth of water at the point, or at the lowest setting on the rod. For streams deeper than 2.5 feet, the two point measurement method (i.e., velocity measurement at 20% and 80% of the total stream depth) is recommended.

Vertical axis current meters do not register velocities accurately when placed close to a vertical wall. A Price meter held close to a right-bank vertical wall will under-register flow because the slower velocity near the wall strikes the effective (concave) face of the cups. The converse is true at a left-bank vertical wall. (The terms "left bank" and "right bank" designate direction from the center of a stream for an observer facing downstream.) The Price meter also under-registers when positioned close to the water surface or close to the streambed.

Equipment

Current meters, timers, depth and width measuring devices, and a means of counting meter revolutions are needed for measurement of discharge. The equipment includes:

- Depth-measuring device, the wading rod
- Current meter
- Width-measuring devices, either engineer's tape or tagline
- Headset
- Stop watch

Depth-Measuring Device. The depth-measuring device that will be used is the top-setting 1/2-inch-diameter hexagonal wading rod. The current meter is attached to the wading rod. The top-setting wading rod consists of a 1/2-inch hexagonal main rod for measuring depth and a 3/8-inch diameter round rod for setting the position of the current meter.

Current Meter. A current meter is an instrument used to measure the velocity of flowing water. The principle of operation is based on the proportionality between the velocity of the water and the resulting angular velocity of the meter's rotor. By placing the current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

The number of revolutions of the rotor is obtained by an electrical circuit through the contact chamber. Contact points in the chamber are designed to complete an electrical circuit at selected frequencies of revolution. The contact chambers selected for discharge measurements at CGS have contact points that will complete the circuit once per revolution. The electrical impulse produces an audible click in a headphone. The intervals during which meter revolutions are counted are timed with a stop watch.

Engineer's Tape or Tagline. Steel, metallic, or fiberglass tapes, or premarked taglines are used for width determinations during discharge measurements made by wading. Direct measurement of width using tapes or taglines can be accurate with proper precautions. Orientation normal to the flow pattern of the river and elimination of most of the sag, through support or tension, are recommended for improved accuracy.

Headset. A headset attaches to an electronic connection at the upper end of the wading rod. The hydrographer wears this headset to listen to audible clicking sounds which are produced when a rotating gear in the current meter makes contact with a thin wire ("cat's whisker") in the contact chamber. The rotating gear contacts the cat's whisker once each time the series of cups on the meter revolves one complete turn. The number of rotations are counted and timed. The first click is counted as zero. The relationship between rotations and time is the point velocity. Velocities as a function of time are listed on a velocity chart, which is kept in the current-meter carrying case.

Stop Watch. A stop watch is used to measure time during which velocity is measured at each point in the cross section. Velocity at each point is measured for a period greater than or equal to 40 seconds and less than or equal to 70 seconds.

Staff Gage. Each location where the velocity-area method will be consistently applied may be equipped with a standard U.S. Geological Survey (USGS) vertical staff gages. The staff gages will be used to measure gage height to the nearest 0.02 of a foot.

Maintenance and Calibration Procedures

Prior to use of the current meter and following use of the meter, spin tests will be conducted to ensure that the unit performs acceptable. The spin test will be performed in an enclosed area, such as in the cab of a truck or in the enclosed rear of a truck, to prevent wind interference. The test is to be performed prior to attaching the current meter to the wading rod. While holding the meter steady in an area sheltered from breezes, the technician will spin the rotor and then press the start button on the stop watch. The technician will observe the meter until the rotor ceases to spin.

The duration of the spin for the pygmy meter should be more than 40 seconds and for the Price AA meter should be more than 90 seconds. If the meter fails to meet the time-of-spin criteria, the meter will be cleaned and oiled before use. If the meter continues to spin well beyond these time limits, the record will indicate that the meter spun for 40+ seconds, in the case of the pygmy meter, or for 90+ seconds, in the case of the Price AA meter.

To ensure reliable observations of velocity, it is necessary that the current meter be kept in good condition. Before and after each discharge measurement, the meter cups or vanes, pivot and bearing, and shaft should be examined for damage, wear, or faulty alignment. During measurements, the meter will be observed periodically when it is out of the water to be sure that the rotor spins freely.

Meters will be cleaned and oiled daily when in use. If measurements are made in sediment-laden water, the meter will be cleaned immediately after each measurement. After oiling, the rotor will be spun to make sure that it operates freely. If the rotor stops abruptly, the cause of the trouble will be sought and corrected before using the meter.

In addition to meter maintenance, the entire unit, consisting of current meter, wading rod, digital counter, and headset, will be checked before departure to the field each day as follows:

- Attach the current meter and digital counter/headset to the wading rod.
- Test the headset by:
  - Spin the current meter to ensure that audible clicks occur.
  - If audible clicks do not occur, the following steps should correct the problem:
    - Check that electronic connections are tight.
    - Check that the cat's whisker lightly contacts the upper part of the shaft.
    - Spin again. If audible clicks still do not occur, check that the battery in the headset is properly aligned. Replace the battery, if necessary.

Field Procedures

Overview. Based on approximate depths, either the Price AA, Marsh-McBirney, or pygmy meter will be selected to perform a velocity-area measurement. Neither the Price AA nor pygmy meter should be used for measuring velocities slower than 0.1 fps unless absolutely necessary. If depths or velocities under natural conditions are too low for a dependable current meter measurement, the cross section will be modified, if practical, to provide acceptable conditions. A shovel will be used to remove aquatic vegetation, ice, or rocks which may interfere with meter operation or discharge measurement.

Before velocity-area measurements are taken, use the staff gage to measure and record the gage height to the nearest 0.02 of a foot.

At each measurement point (or station) across the stream cross section, depth is measured prior to measurement of velocity. Therefore, it is recommended that the wading rod be set with the current meter suspended out of the water and above the tagline, which is used to measure width and to identify stations across the cross-section. Placement of the rod about 0.5 feet downstream from the tagline prevents contact between the tagline and the current meter when the meter is lowered into measuring position.

The wading rod will be placed in the stream so the base plate rests on the streambed, and the depth of water will then be read from the graduated main rod. The main rod is graduated into 0.1-foot increments: these increments are indicated by a single score in the metal. Half-foot increments are marked by two scores in the metal, and each foot is marked by three scores in the metal. A vernier scale on the upper handle of the rod corresponds to 0.1-foot increments. The top-setting rod, to which the meter is attached, has single scored marks which are aligned with values on the vernier scale.

The hydrographer reads water depth directly from the main rod. In high velocity areas, it is recommended that depth be read as the value between the depth on the upstream side of the rod and the depth on the downstream side of the rod. Depth is measured to the nearest 0.02 foot. This depth is used to set the vertical location on the current meter.

Next, the top-setting rod is adjusted downward so that the scored mark which corresponds to the range of depth in feet (e.g., if depth = 0.46, range in feet = 0; or if depth = 1.72, range in feet = 1) is aligned with the stream depth value transposed to the vernier scale. This automatically positions the meter for use in the 0.6 method as the meter is then six-tenths of the total depth from the surface of the water. If depths are less than 0.30 foot, the 0.5-method may be used. The observed depth will then be 0.5 of the total depth.

The hydrographer will stand in a position that least affects the velocity of the water passing the current meter. That position is obtained by facing upstream while holding the wading rod vertically and close to the tagline or measuring tape. The hydrographer stands at about a 45-degree angle downstream from the wading rod and at least 1.5 feet from the wading rod. This angle is an imaginary angle between the extended arm holding the wading rod and the tagline or measuring tape. The hydrographer should avoid standing in the water if his or her feet and legs occupy a significantly large percentage of a narrow cross section. For narrow streams, it is often possible to stand astride the stream.

The wading rod should be held in a vertical position with the meter parallel to the direction of flow while the velocity is being observed. When measuring streams that have shifting beds, the soundings or velocities can be affected by the scoured depressions left by the hydrographer's feet. For such streams, the meter should be placed ahead of and upstream from the hydrographer's feet.

Once the velocity-area measurements have all been taken, measure and record the gage height from the staff gage to the nearest 0.02 foot again.

Steps to be followed in Measuring Discharge. Water quality and bed material samples will be collected prior to making discharge measurements. The following steps are to be followed in discharge measurement:

- Use the staff gage to measure and record the gage height to the nearest 0.02 of a foot.
- Measurement notes should be recorded on the Discharge Measurement Form at each subsection of the cross section as the measurement is performed. If two people are performing the measurement, the hydrographer may state the stations, depths, counts, and number of seconds to a note keeper. The note keeper would then repeat each value stated by the hydrographer to ensure agreement between the value stated by the hydrographer and the value heard by the note keeper.
- Record on the Discharge Measurement Form the following: distance from initial point, width, depth, observation depth, revolutions, time in seconds, velocity, area, discharge.
- Note the distance in feet in terms of stream direction that this cross section lies from the prescribed location. For example, the note may read "25 feet downstream" or "15 feet upstream." This is recorded in a manner similar to that on the front of the Discharge Measurement Form.
- If the selected cross section contains aquatic growth, ice, boulders, or slack-water areas that can either interfere with operation of the current meter or otherwise impede accurate measurement, use a shovel to remove minor flow impediments.
- Several measurement locations are required from one side of the stream to the other. Select the approximate number of subsections at which to take measurements as listed on Table 1. Position a tape (for small streams) or the tagline (for large streams) about one foot above the surface of the water. Secure the tape so that it remains taut and perpendicular to the channel.
- Select a starting point at either the left bank (left edge of water, LEW) or the right bank (right edge of water, REW), which is determined by facing downstream.
- Measure the width of the stream in feet. After selecting the Marsh McBirney, the Price AA or pygmy meter (see Table 2), follow Table 1 to select the number of subsections in which to measure velocity. The goal in selection of measurement stations is to measure no more than ten percent of the total discharge in any given subsection. Subsections need not be identical in width. Use more observation

points in deep areas or portions of the channel having higher velocities. Frequently, fewer observation points are needed near the shore than near the center of the stream. Obvious breaks in streambed configuration are also proper locations at which to measure velocities.

- After determining the desired distance between stations, measurement can begin. Record the time and bank at which measurement starts on the discharge measurement note as "REW Start 0000", using REW or LEW, depending upon whether starting at the right or the left edge of the water. 24-hour clock time is used, and is recorded to the nearest five minutes.
- Note the distance to the beginning edge of water from the initial point. The initial point is an arbitrary point on the tape, preferably a whole number, which lies on the shoreside of the stream. All subsequent station locations are recorded as distances from the initial point.
- Proceed to the first station. Record the distance from the initial point on the discharge note.
- Stand downstream of the tagline or tape and face upstream. begin with the current meter on the wading rod well above the surface of the water.
- Measure stream depth at the measurement point on the wading rod. Individual lines on the wading rod indicate 0.10-foot increments; double lines indicate 0.50-foot increments, and triple lines indicate 1.00-foot increments. Record the stream depth to the nearest 0.02 feet: for example 0.32 feet or 1.54 feet.
- Lower the meter to the required depth and record the observation depth in the logbook. The observation depth as a fraction of total depth is usually 0.6, or 0.5 for subsections having depth of less than 0.3 feet.
- Stand downstream of the meter with the arm fully extended as you hold the wading rod. Position yourself so that the angle measured between the arm and the tagline is about 45 degrees. Stand as far away from the vertically held wading rod as possible.
- Start the stopwatch and begin counting clicks. The first click is counted as zero.
- After at least 40 but as much as 70 seconds have passed, stop the stopwatch. Record number of seconds and number of revolutions (clicks) on the same line of the note as the depth was recorded.
- Determine velocity as a function of elapsed time and number of revolutions from the velocity chart. Record velocity next to the other values for this station.
- Proceed to the next station. Record the distance from the initial point to the station. Repeat measurements of depth and velocity. Continue in this manner across the stream.
- After recording the distance measurement at the last station, record the time at which the ending edge of water is reached as "LEW (or REW) FINISH 1330."
- Note velocity and depth at the edge of water as zero.
- Following velocity-depth measurements, use the staff gage again to measure and record the gage height to the nearest 0.02 of a foot.
- Evaluate and record on the data collection note the following: Flow characteristics, weather, air temperature, water temperature, observer(s), type of meter, and remarks.

- For QA/QC purposes, each team should make repeat measurements at a station to document method precision. These measurements should be conducted at a minimum of one per every 20 flow measurements.

Discharge Calculations

A stream discharge is the summation of the products of the subsection areas of the stream cross section and their respective average velocities. The formula:

$$Q = \Sigma(av)$$

represents the computation, where Q is the total discharge, a is an individual subsection's area, and v is the corresponding mean velocity of flow normal to the subsection. The summation of the discharges for all the subsections is the total discharge for that stream cross section. The order for calculating discharge is:

- Use the distances from initial point to compute width for each section. The first width is computed by subtracting the first distance from the second distance, and dividing this quantity by two. The second width is the difference between the third distance and the first distance, divided by two. For each subsequent width, subtract the distance on the line above the line you are calculating from the distance on the line below the line you are calculating, and divide this quantity by two. This procedure is carried out for each line until you reach the final width calculation. This is calculated as the difference between the final and the second-to-last distance, divided by two.
- Subsequent calculations will be performed as follows:
  - Calculate each discharge for each subsection by multiplying the width of the subsection times the depth times the velocity.
  - Sum the discharges for each subsection to arrive at total discharge for the entire cross section.
  - If the two-point measurement method was employed, average velocities to obtain a "mean" velocity for the partial section.
- Check your math by summing the subsection widths. Their total should equal the value obtained by taking the difference between the LEW and the REW station distances from initial point.
- Initial at the line "Comp. by" to identify yourself as the person responsible for performing the discharge calculation.

3.2 Flumes

3.2.1 Theoretical Considerations

Flumes are specially shaped open-channel flow devices that constrict channel area and change the slope to force the flow through critical depth. Typical flumes consist of three sections:

- A converging section to accelerate the approaching flow
- A throat section, whose width is used to designate flume size

- A diverging section, designed to ensure that the level downstream is lower than the level in the converging section

The hydraulic theory behind flume is based on a calibrated constriction placed to change the level of the water in or near the constriction. By knowing the dimensions of the constriction, the discharge though the constriction will be a function of the water level. A simple depth determination near the constriction provides a discharge measurement. Flumes are constructed so that a restriction in the channel causes the water to accelerate, producing a corresponding change (drop) in the water level. The head can then be related to discharge.

3.2.2 Required Measurement Conditions

The flow rate through a flume is determined by measuring the gage (flow depth) at a single point upstream from the throat. Pressure transducers and data loggers maybe installed to continuously record gage depth. The gage height measurement determines the discharge only if critical flow is achieved in the throat of the flume. By definition, critical flow is when the ratio of force due to inertia to the force due to gravity (Froude number) is unity. Supercritical flow occurs when the Froude number exceeds unity. If the Froude number is less than one, subcritical flow occurs, commonly due to a condition referred to as submergence. If submergence exists, a second depth reading must be taken in the throat section to determine the flow rate. Additional information concerning the use of flumes under all flow conditions, including submergence, is found in USGS Water Supply Paper 2175, Volume 2, Chapter 10.

3.2.3 Equipment

For purposes of discharge measurements at CGS, existing flumes located at some of the surface water sites will be inspected and flow rates measured prior to sampling. Additional flumes may be permanently or temporarily installed at some sites.

<u>Parshall Flume.</u> The Parshall flume consists of a converging section with a level floor, a throat section with a downward sloping floor, and a diverging section with an upward sloping floor. The principal feature of the Parshall flume (developed by R. Parshall in 1922) is an approach reach having converging sidewalls and a level floor of which the downstream end is a critical-depth section. Critical flow is established at the throat due to a sharp downward break in the slope of the flume. The slope downstream from the level approach section is therefore supercritical. The primary gage height measurement is made in the approach reach at a standard distance upstream from the critical-depth cross section.

<u>Portable Flume.</u> A bed slope of less than one percent for a distance of four to six feet upstream of a portable cutthroat flume is necessary for proper operation for throat widths ranging from one to six inches. Also, a flow width equal to at least two times the front width of the flume is recommended upstream of the flume. The flume must be installed level, plumb and square. All of the flow must be diverted into the flume inlet. After the flow has equilibrated, the up and downstream staff gages provided in the flume should be read and flow depths recorded. The flume should be installed so free-flow occurs, that is the flow through the flume reaches critical depth in the vicinity of minimum width in the flume. If free-flow conditions exist, only the upstream gage needs to be read. For submerged flow conditions both the upstream gage (head) and downstream gage needs to be read to determine discharge.

3.2.4 Maintenance and Calibration Procedures

All flumes will be inspected prior to measurement of discharge to determine that the flume is discharging freely. Any problems observed during the inspection will be noted and reported to the site supervisor.

3.2.5 Field Procedures

Overview. If the site is equipped with a permanent flume, then discharge will be measured as described below.

Steps to be Followed in Measuring Discharge from a Permanent Flume

- Remove any material that may have accumulated in the flume.
- Note any deterioration of the flume; report these conditions to the project technical consultant at the conclusion of daily data collection activities.
- Measure and record the throat width to the nearest 0.01 of a foot.
- Record the time and date of the site visit.
- Use the staff gage to measure and record the gage height to the nearest 0.02 of a foot.
- Calculate discharge using tables or equations suitable for the width and type of flume located in Appendix B.
- Record the calculated discharge (Should any leakage occur around the flume, the amount of leakage is estimated as a percent of the total measured flow and added to the calculated flow value).

Steps to be followed Measuring Discharge from a Portable Flume

- Remove any material that hinders ability to form a flat surface for flume to be level, plumb, and square. Use a leveling device to ensure the flume is level and plumb.
- Follow the steps measuring discharge from a permanent flume.

3.3 Volumetric Method

The volumetric method consists of capturing flow in a container and measuring the time required to fill the container. This may be accomplished by building a small earthen dike to divert the flow through a pipe, temporarily placed in the channel, into a container with a known calibrated volume. The container is placed below the discharge pipe, and the time required to fill the known volume is recorded with a stopwatch. The measurement is repeated at least three times and the resulting values averaged. If the variance between the time measurements exceeds ten percent, the measurement procedure is repeated. Should any leakage occur through or around the dike, the amount of leakage is estimated as a percent of the total measured flow and added to the calculated flow value. Required Measurement Conditions

The volumetric method of measurements is best used for measurement of small flows that are immeasurable by other methods, and can be diverted through a pipe. The flow has to be fully controlled through the pipe with no leakage through or around constructed dike.

3.3.1 Equipment

Equipment necessary to measured discharge includes: smooth section pipe, graduated container or container of known volume, stop watch.

3.3.2 Maintenance and Calibration Procedures

The pipe and container will be inspected for damage prior to use. If any cracks or holes exist in the pipe or container, the pipe shall be replaced. Only a pipe with a smooth surface shall be used. The volume of the container will be determined and documented.

APPENDIX A
SURFACE WATER DATA SHEET AND DISCHARGE MEASUREMENT FORM

SURFACE WATER DATA SHEET

IDENTIFICATION

Sample Location_________________________ Date __________ Time ______ Page__ of

Sample Control Number______________________ Samplers ____

WEATHER CONDITIONS

Ambient Air Temperature: _____ °C ☐ °F ☐ Not Measured? ☐

Precipitation: None ☐ Rain ☐ Snow ☐ Heavy ☐ Moderate ☐ Light ☐ Sunny ☐ Partly Cloudy ☐

INSTRUMENT CALIBRATION

pH pH meter number:

Buffer ______ Measured Value ______ Temperature _____ °C ☐ °F ☐

Buffer ______ Measured Value ______ Temperature _____ °C ☐ °F ☐

Conductivity Meter Calibration/Measurement Meter number:

Standard Value ______ µS/cm Measured Standard Value ______ µS/cm Temperature _____ °C ☐ °F ☐

Standard Value ______ µS/cm Measured Standard Value ______ µS/cm Temperature _____ °C ☐ °F ☐

SAMPLE LOCATION DESCRIPTION

____

____

____

____

SAMPLE COLLECTION PROCEDURE

____

____

____

____

____

DISCHARGE MEASUREMENT

Method: Meter Type/Model/Serial No.:

Comments/Observations:

____

____

____

____

____

____

Discharge _____________ Staff gauge

Final Sample Parameters

Sample Date	Sample Time	Discharge	pH	Cond. (µS/cm)	Temp. °C ☐ °F ☐	Turbidity (Visual Estimate)

Was a duplicate sample collected? Yes ☐ No ☐ (sample control number________________)

Was a field blank collected? Yes ☐ No ☐ (sample control number________________)

Was a rinsate sample collected? Yes ☐ No ☐ (sample control number________________)

Notes ____

____

____

____

____

DISCHARGE MEASUREMENT FORM

Sample Location: ______________________________ Date: _________________ Samplers: ____________________________

Method: ______________________________________ Meter Type/Model/Serial No.: __________________________________

Observations: ____

____

____

____

DIST FROM INIT POINT	WIDTH (FT)	DEPTH (FT)	OBSER DEPTH	REVS	TIME (SEC)	VELOCITY (F/S)		AREA (FT)	DISCHARGE (CFS)
						AT POINT	MEAN IN VERTICAL		
	LEW or REW (circle one) at time= ____________								
	LEW or REW (circle one) at time= ____________								

APPENDIX B
FLUME DISCHARGE CALCULATIONS

PARSHALL FLUME DISCHARGE CALCULATION

Flume Size (incl. discharge [cfs])

1	.5*(h(ft)^2)
2	1.02*(h(ft)^2)
4	2.08*(h(ft)^2)
8	4.22*(h(ft)^2)
6	2.060*(h(ft)^1.580)
9	3.070*(h(ft)^1.530)
12	4*(h(ft)^1.522)
18	6*(h(ft)^1.538)

h=staff gauge reading (ft)
cfs*440.83 = gpm

Collapsible Cutthroat Flume

For free discharge, downstream height ÷ by upstream height must be less than 0.5.

Upstream Gauge (ft)	gpm 1"	gpm 2"	gpm 4"	gpm 8"	cfs 1"	cfs 2"	cfs 4"	cfs 8"
0.10	2.25	4.58	9.32	19.0	0.005	0.010	0.021	0.042
0.11	2.72	5.54	11.3	23.0	0.006	0.012	0.025	0.051
0.12	3.24	6.60	13.4	27.4	0.007	0.015	0.030	0.061
0.13	3.80	7.74	15.8	32.1	0.008	0.017	0.035	0.072
0.14	4.41	8.98	18.3	37.2	0.010	0.020	0.041	0.083
0.15	5.06	10.3	21.0	42.8	0.011	0.023	0.047	0.095
0.16	5.76	11.7	23.9	48.6	0.013	0.026	0.053	0.108
0.17	6.50	13.2	26.9	54.9	0.014	0.029	0.060	0.122
0.18	7.29	14.8	30.2	61.6	0.016	0.033	0.067	0.137
0.19	8.12	16.5	33.6	68.6	0.018	0.037	0.075	0.153
0.20	9.00	18.3	37.3	76.0	0.020	0.041	0.083	0.169
0.21	9.92	20.2	41.1	83.8	0.022	0.045	0.092	0.187
0.22	10.9	22.2	45.1	92.0	0.024	0.049	0.101	0.205
0.23	11.9	24.2	49.3	101	0.027	0.054	0.110	0.224
0.24	13.0	26.4	53.7	109	0.029	0.059	0.120	0.244
0.25	14.1	28.6	58.3	119	0.031	0.064	0.130	0.265
0.26	15.2	31.0	63.0	128	0.034	0.069	0.140	0.286
0.27	16.4	33.4	67.9	139	0.037	0.074	0.151	0.309
0.28	17.6	35.9	73.1	149	0.039	0.080	0.163	0.332
0.29	18.9	38.5	78.4	160	0.042	0.086	0.175	0.356
0.30	20.3	41.2	83.9	171	0.045	0.092	0.187	0.381
0.31	21.6	44.0	89.6	183	0.048	0.098	0.200	0.407
0.32	23.0	46.9	95.4	195	0.051	0.104	0.213	0.434
0.33	24.5	49.9	101	207	0.055	0.111	0.226	0.461
0.34	26.0	52.9	108	220	0.058	0.118	0.240	0.489
0.35	27.6	56.1	114	233	0.061	0.125	0.254	0.519
0.36	29.2	59.4	121	246	0.065	0.132	0.269	0.549
0.37	30.8	62.7	128	260	0.069	0.140	0.284	0.580
0.38	32.5	66.1	135	274	0.072	0.147	0.300	0.611
0.39	34.2	69.7	142	289	0.076	0.155	0.316	0.644
0.40	36.0	73.3	149	304	0.080	0.163	0.332	0.677
0.41	37.8	77.0	157	319	0.084	0.172	0.349	0.712
0.42	39.7	80.8	164	335	0.088	0.180	0.366	0.747

Collapsible Cutthroat Flume

For free discharge, downstream height ÷ by upstream height must be less than 0.5.

Upstream Gauge (ft)	gpm 1"	gpm 2"	gpm 4"	gpm 8"	cfs 1"	cfs 2"	cfs 4"	cfs 8"
0.43	41.6	84.7	172	351	0.093	0.189	0.384	0.783
0.44	43.6	88.7	180	368	0.097	0.198	0.402	0.820
0.45	45.6	92.7	189	385	0.102	0.207	0.421	0.857
0.46	47.6	96.9	197	402	0.106	0.216	0.439	0.896
0.47	49.7	101	206	420	0.111	0.225	0.459	0.935
0.48	51.8	106	215	438	0.116	0.235	0.478	0.975
0.49	54.0	110	224	456	0.120	0.245	0.499	1.02
0.50	56.3	115	233	475	0.125	0.255	0.519	1.06
0.51	58.5	119	242	494	0.130	0.265	0.540	1.10
0.52	60.8	124	252	514	0.136	0.276	0.562	1.14
0.53	63.2	129	262	534	0.141	0.287	0.583	1.19
0.54	65.6	134	272	554	0.146	0.298	0.606	1.23
0.55	68.1	139	282	575	0.152	0.309	0.628	1.28
0.56	70.6	144	292	596	0.157	0.320	0.651	1.33
0.57	73.1	149	303	617	0.163	0.332	0.675	1.38
0.58	75.7	154	314	639	0.169	0.343	0.699	1.42
0.59	78.3	159	324	661	0.175	0.355	0.723	1.47
0.60	81.0	165	336	684	0.180	0.367	0.748	1.52
0.61	83.7	170	347	707	0.187	0.380	0.773	1.58
0.62	86.5	176	358	730	0.193	0.392	0.798	1.63
0.63	89.3	182	370	754	0.199	0.405	0.824	1.68
0.64	92.2	188	382	778	0.205	0.418	0.851	1.73
0.65	95.1	194	394	803	0.212	0.431	0.877	1.79
0.66	98.0	200	406	828	0.218	0.444	0.905	1.84
0.67	101	206	418	853	0.225	0.458	0.932	1.9
0.68	104	212	431	879	0.232	0.472	0.96	1.96
0.69	107	218	444	905	0.239	0.486	0.989	2.02
0.70	110	224	457	931	0.246	0.500	1.02	2.07
0.71	113	231	470	958	0.253	0.514	1.05	2.13
0.72	117	237	483	985	0.26	0.529	1.08	2.19
0.73	120	244	497	1013	0.267	0.544	1.11	2.26
0.74	123	251	510	1040	0.275	0.559	1.14	2.32
0.75	127	258	524	1067	0.282	0.574	1.17	2.38

O&M SOP-6

SOP Date: May 2008

SURFACE WATER SAMPLE COLLECTION

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for collection of surface water samples at the California Gulch CERCLA Site. This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect surface water samples from streams and surge pond areas. The sample locations and frequency of collection are specified in specific Operable Unit workplans/sampling and analysis plans.

This procedure is intended to be used together with several other SOPs including:

- SOP 1 Decontamination
- SOP 3 Field Instrument Calibration and Operation
- SOP 5 Surface Water Flow Measurement
- SOP 7 Sample Handling, Documentation, and Analysis
- SOP 10 Field QA/QC Samples

2.0 SURFACE WATER SAMPLING

2.1 Sampling Methods

This section discusses the criteria for the selection of sampling methods and equipment. The selection of sampling methods and equipment is based on sample type, flow conditions, and data quality objectives stated in the sampling workplan. Selection of sampling methods and equipment based on flow conditions is as follows:

- If the stream is less than 3 ft wide, collect samples from the center of the flow. Use a dipper or a beaker to collect samples into the churn splitter and distribute the sample water from the churn splitter into the sample bottles. Alternately, pump directly from the stream into the sample bottles with a peristaltic pump and Tygon or silicon tubing, or immerse the bottles in the center of flow with the bottle mouth facing up stream. Triple rinse the sample containers with sample water and then fill the sample bottles. If not enough sample water is available to perform the triple rinse, then at a minimum a single rinse will be performed and will be recorded in the field logbook and/or data sheet. Cap the sample containers quickly. If sample bottles are pre-preserved, fill the sample bottles without rinsing. Add preservative if the bottle is not pre-preserved. Do not allow the sample containers with preservatives to overflow.
- If the stream is greater than 3 ft wide, use the horizontal areal composite method: Collect aliquots of sample from 3 stations spaced evenly across the stream. If the

stream is too deep to wade, collect a grab sample from the bank. Combine these in the churn splitter and fill sample bottles as described above.

2.2 Equipment List

Sample bottles with preservatives added (preservatives may be added in the field) will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.

Equipment used during surface water sample collection is listed on the field equipment checklist (see Appendix A). This list will be checked before departing to the field.

2.2.1 USGS Churn Splitter

The churn splitter is a device which mixes (homogenizes) sample aliquots to form a sample composite and then splits the composite into discrete samples. Samples may be taken from the churn splitter for analysis of all dissolved and suspended inorganic constituents with the exception of total organic carbon (TOC), fecal coliform, volatile organic analyses (VOAs), and oil and grease (O&G). The churn splitter is used to mix the surface water sample while splitting the total volume into the various analyte samples.

Samples collected are composited and split in either an 8-liter or a 14-liter churn splitter. A total of 10 liters of the sample mixture can be withdrawn from the 14-liter churn; the remaining 4 liters should not be used directly because they will not be representative. Similarly, 5 liters can be withdrawn from the 8-liter churn. The sample mixture remaining in either churn can, however, be used for filtered samples. Unfiltered water samples should be withdrawn first and then filtered samples may be taken from the churn bucket with a peristaltic pump.

2.3 Sampling Procedures

This section gives the step-by-step procedures for collecting samples in the field. Observations made during sample collection should be recorded on the Surface Water Data Sheet (Appendix B).

Samples will be collected from the same cross section of the stream as that which is to be used for the discharge measurement, if discharge is measured. Always collect samples prior to making discharge measurements. Stand downstream of the water to be sampled.

2.3.1 Decontamination Equipment

Before any sampling begins, and between samples, all sample collection equipment shall be decontaminated. If dedicated equipment is used, it will be rinsed with deionized water. If nondedicated equipment is used, it will be washed with Alconox Soap (or equivalent), rinsed with potable water, then rinsed with deionized water, and placed in clean plastic bags. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. A discussion of personnel decontamination is contained in the site Health and Safety Plan. See SOP No. 1 for additional information on decontamination procedures.

2.3.2 Instrument Calibration

Electronic equipment used during sampling may include a pH meter with temperature scale and a conductivity meter. Before going into the field, the sampler shall verify that all of these are operating properly. The pH and conductivity meters require calibration prior to use every day. Calibration times and appropriate readings will be recorded in the field notebook. Specific instructions for calibrating the pH meter and conductivity meter are given in SOP 3.

2.3.3 Filtering Samples

Total metals, conductivity, pH, and solids analyses are performed on unfiltered samples. Samples will be filtered in the field by using a disposable 0.45µm membrane filter apparatus and peristaltic or hand vacuum pump. Note: sample analysis may not include all parameters discussed in this section.

Filtered samples will be collected according to the following procedure:

- Assemble filter device according to manufacturer's instructions.
- Filter sample either by pouring sample in the top portion of filter unit or pumping it through Tygon® or silicone tubing and an in-line filter using a peristaltic pump. Composited sample remaining in the churn splitter may be used for filtered sample.
- Transfer filtered sample to appropriate sample bottles Triple rinse the sample containers with filtered sample water and then fill the sample bottles. If not enough sample water is available to perform the triple rinse, then at a minimum a single rinse will be performed and will be recorded in the field logbook and/or data sheet. Cap the sample containers quickly. If sample bottles are pre-preserved, fill the sample bottles without rinsing. Add preservative if the bottle is not pre-preserved. Do not allow the sample containers with preservatives to overflow.
- Dispose of the used filter cartridge and tubing.

2.3.4 Field Quality Assurance/Quality Control Samples

Field QA/QC sample collection is discussed in SOP 10.

2.4 Sample Handling

Sample containers and preservatives are specified in SOP No. 7, Sample Handling, Documentation, and Analysis. Samples will be labeled and handled as described in SOP No. 7.

2.5 Documentation

A Surface Water Data Sheet will be completed at each sample location. Items not applicable to the sampling will be labeled as not applicable (NA). The information on the data sheet will include the following:

- Sampling location
- Date and time of sampling
- Weather conditions
- Persons performing sampling
- Conductivity, temperature, and pH during sampling

- Color, odor, and cloudiness of the water
- Sample identification numbers
- Identification numbers of any QC samples from site
- Any irregularities or problems which may have a bearing on sampling quality

3.0 FLOW RATE MEASUREMENT

After collecting surface water samples, the surface water flow rate will be measured to ascertain the surface water flow conditions at the time of sample collection. Surface water flow rate procedures are described in SOP No. 5,

4.0 SURGE POND WATER VOLUME

After collecting surface water samples, the surge pond water volume will be measured to ascertain the surface water conditions at the time of sample collection. The volume of water contained in the surge pond should be measured using the staff gauge as described in SOP No. 9 — Surge Pond Staff Gauge.

APPENDIX A
FIELD EQUIPMENT CHECKLIST

FIELD EQUIPMENT CHECKLIST

Sampling Equipment

Conductivity Meter
pH meter w/temperature scale
Conductivity standards
pH Buffers
Containers for field parameter measurement
Samplers for all sampling conditions (i.e., dip sample)
Churn splitter
Sample bottles
Sample labels
Peristaltic pump
Tygon or silicon tubing
Disposable Filters
Plastic storage bags for samples
Coolers containing sample containers
Blue ice
Extra sample containers
Chain-of-custody forms
Gloves

Personal Equipment

PPE, as discussed in the Health & Safety Plan
Wrist or pocket watch
Rain gear
Duct tape
Pocket knife
First aid kit

Stream-Gaging Equipment

Marsh-McBirney Current Velocity meter, or Velocity charts for Price AA meter and Pygmy meter
Type AA current meters with spare parts (for high flow conditions only)
1 pygmy meter, with very small screwdriver
1 wading rod (complete)
1 head set (complete for wading measurements) and/or velocity meter
1 stop watch
Calibrated volumetric containers (for pipe flow measurements only)
Steel or fiberglass measuring tapes
Meter oil
Shovel
Level
Portable, adjustable width Cutthroat flume
Waders or hip boots

Decontamination Equipment

Alconox or a nonphosphate detergent, such as Liquinox
Buckets with lids
Brushes
Distilled water
Potable water
Decon water containers
Paper towels
Clean plastic bags

Forms and Supplies

Chain-of-Custody Forms
Sample container labels
Applicable SOPs, HSP, equipment manuals, work plan and other required documentation
Chain-of-Custody Checklist
Surface Water Data Collection Sheet and Discharge Measurement Note
Logbook

APPENDIX B
SURFACE WATER DATA SHEETS

SURFACE WATER DATA SHEET

IDENTIFICATION

Sample Location__________________________ Date ___________ Time _______ Page__ of

Sample Control Number_______________________ Samplers ____

WEATHER CONDITIONS

Ambient Air Temperature: _____ °C ☐ °F ☐ Not Measured? ☐

Precipitation: None ☐ Rain ☐ Snow ☐ Heavy ☐ Moderate ☐ Light ☐ Sunny ☐ Partly Cloudy ☐

INSTRUMENT CALIBRATION

pH pH meter number:

Buffer ______ Measured Value ______ Temperature _____ °C ☐ °F ☐

Buffer ______ Measured Value ______ Temperature _____ °C ☐ °F ☐

Conductivity Meter Calibration/Measurement Meter number:

Standard Value ______ µS/cm Measured Standard Value ______ µS/cm Temperature _____ °C ☐ °F ☐

Standard Value ______ µS/cm Measured Standard Value ______ µS/cm Temperature _____ °C ☐ °F ☐

SAMPLE LOCATION DESCRIPTION

SAMPLE COLLECTION PROCEDURE

DISCHARGE MEASUREMENT

Method: Meter Type/Model/Serial No.:

Comments/Observations:

Discharge ______________ Staff gauge

Final Sample Parameters

Sample Date	Sample Time	Discharge	pH	Cond. (µS/cm)	Temp. °C ☐ °F ☐	Turbidity (Visual Estimate)

Was a duplicate sample collected? Yes ☐ No ☐ (sample control number_________________)

Was a field blank collected? Yes ☐ No ☐ (sample control number_________________)

Was a rinsate sample collected? Yes ☐ No ☐ (sample control number_________________)

Notes ____

DISCHARGE MEASUREMENT FORM

Sample Location: ____________________________ Date:________________ Samplers:__________________________

Method: ____________________________________ Meter Type/Model/Serial No.:_______________________________

Observations:____

____

____

____

DIST FROM INIT POINT	WIDTH (FT)	DEPTH (FT)	OBSER DEPTH	REVS	TIME (SEC)	VELOCITY (F/S)		AREA (FT)	DISCHARGE (CFS)
						AT POINT	MEAN IN VERTICAL		
	LEW or REW (circle one) at time= ____________								
	LEW or REW (circle one) at time= ____________								

O&M SOP-7

SOP Date: May 2008

SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard protocols for sample handling, documentation, and analysis for California Gulch CERCLA Site. This procedure is intended to be used together with other SOPs and is referenced in all SOPs that apply to sampling.

2.0 PROCEDURES FOR SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

2.1 Sample Identification and Labeling

Samples collected during monitoring, investigations, or remediation activities will be assigned unique sample identification numbers. Each sample identification number will identify the organization collecting the sample or the program under which it is collected, sampling location, type of sample, and sampling sequence for each sample. These numbers are required for tracking the handling, analysis, and verification or validation status of all samples collected during monitoring. In addition, the sample identification numbers will be input into the project database to identify analytical results received from the laboratory.

Sample identification numbers that are assigned will be divided into four fields as shown in the following example:

R-CGMW1-01-900423

The first field is one character in length and identifies the company conducting the sampling. The second field is an alphanumeric code identifying the location of the sample and the last letter of this field indicates the matrix (e.g., CGMW1 indicates California Gulch Monitoring Well No. 1, the second W indicates a water matrix). The next field identified is the type of sample being collected; this is used to identify whether the sample is a primary or grab sample, a composite sample, field duplicate, field blank, or equipment rinsate. The final field contains the date in a year-month-day format to allow data in the analytical database to be easily sorted. For example, the sample identified above was collected on April 23, 1990. Table 1 provides a list of the possible code entries for each of the data fields for routine monitoring samples.

Each sample that is collected in the field will be labeled for future identification. Sample labels will be filled out as completely as possible by a member of the sampling team prior to the start of the day's field sampling activities. The date, time, sampler's signature, and the last field of the sample identification number should not be completed until the sample is actually collected. All sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Sampler's company affiliation;
- Site location;
- Sample identification;
- Date and time of sample collection;
- Method of preservation used;
- Sample matrix; and
- Sampler's initials.

2.2 Sample Containers, Preservatives, and Holding Times

2.2.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, commercially-cleaned sample containers will be obtained from the analytical laboratory. The bottles will be labeled as described in the previous section to indicate the type of sample and sample matrix to be collected. Sample bottles can be either pre-preserved from the laboratory or preservatives can be added in the field during sample collection.

2.2.2 2Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to ensure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping. Sample preservation requirements are based on the most current publication of 40 CFR, Part 136.3 and are provided in Table 2.

2.2.3 Sample Holding Times and Analyses

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and/or extraction, based on the nature of the analyte of interest and chemical stability factors. Holding times applicable for analytes are listed in Table 2. Samples should be sent to the laboratory as soon as possible after collection by hand delivery or an overnight courier service to minimize the possibility of exceeding holding times.

For most samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

The chemical constituents for which samples from all current sampling programs will be analyzed are summarized in the project QAPP.

2.3 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in the previous discussion, and placed on ice in an insulated cooler. The sample containers will be placed in re-closeable plastic storage bags. Samples will then be placed right side up in a cooler with ice for delivery to the laboratory. The ice in the cooler will be double-bagged. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal. Final packaging and shipping will be conducted in compliance with current IATA Resolution 618 and DOT 49 CFR Part 171 Regulations.

All samples will be shipped for laboratory receipt and analysis within the holding times specified in Table 2. This may require daily shipment of samples with short holding times.

2.4 Sample Documentation and Tracking

This section describes the information that should be provided in field notes and sample Chain-of-Custody documentation.

2.4.1 Field Notes

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, and a permanent record of field activities. Field observations and data collected during routine monitoring activities will be recorded with waterproof ink in a permanently bound weatherproof field log book with consecutively numbered pages or on field data sheets as specified in the project SOPs.

Field notebook and/or data sheet entries will, at a minimum, include the information listed below. Relevant SOPs should be consulted to supplement this list.

- Project name;
- Location of sample;
- Data and time of sample collection;
- Sample identification numbers;
- Description of sample (matrix sampled);
- Sample depth (if applicable);
- Sample methods, or reference to the appropriate SOP;
- Field observations;
- Results of any field measurements, such as depth to water, pH, temperature, specific conductance; and
- Personnel present.

Changes or deletions in the field book or on the data sheets should be recorded with a single strike mark, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without having to rely on the collector's memory.

All field books will be signed on a daily basis by the person who has made the entries. Anyone making entries in another person's field book will sign and date those entries.

2.4.2 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Establishment of traceability of data is crucial for resolving future problems if analytical results are called into question and for minimizing the possibility of sample mix-up. Initial information concerning collection of the samples will be recorded in the field log book or on data sheets as described above. Information on the custody, transfer, handling and shipping of samples will be recorded on a Chain-of-Custody (COC) form.

The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. A COC form will be completed for each set of water quality samples collected, and will contain the following information:

- Sampler's signature and affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping air bill number (if the samples are shipped)
- Any additional instructions to the laboratory.

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples. Upon arrival at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project Manager. Copies of all COC documentation will be compiled and maintained in the central files. The original COC forms will remain with the samples until the time of final disposition. After returning samples for disposal, the laboratory will send a copy of the original COC to the Operator. This will then be incorporated into the central files.

Table 1 Sample Identification Codes

Example Sample I.D.	R-MWBB1-W-01-911217	
	R =	Sampling company (i.e., Resurrection)
	BBW1 =	Sampling location and matrix (i.e., MWBB1 indicates Monitoring Well BB-1, second W indicates a water matrix)
	01 =	Type of sample (i.e., primary sample)
	911217 =	Date of sample collection (Year Month Day) (i.e., December 17, 1991)

First field will be: "R" for Resurrection, "RA" for Res-ASARCO Joint Venture or other letters to identify subcontractor collecting samples

OU1 Second field will be: "YFW" for Yak Portal Discharge Water, or
"BBWI" for Monitoring Well BBW-1, or
"SEW" for Surface Water, or
"SPW" for Surge Pond Water, or
"SSW" for Seep or Spring Water, or
"SPS" for Surge Pond Sediment, or
"WPE" for Water Treatment Plant, or
"GIL" for Gravity Influent Line, or
"SPIL" for Surge Pond Influent Line, or
"WE5" for EPA well MW5, or
"W5A" for EPA well MW5A, or
"W5B" for EPA well MW5B, or
“BTL” for Blockage Water

Third field will be:
"01" for primary sample or grab sample
"02" for field duplicate sample
"03" for field blank
"04" for equipment rinsate

Fourth field will be:
YEAR MONTH DAY
Date sample collected

Table 2 Sample Containers, Preservation Methods, and Holding Times

Analyte	Container[(1)]	Filtration[(2)]	Preservation	Holding Time[(3)]
pH	P,G	No	Cool, 4°C	7 days[(4)]
Specific conductance	P,G	No	Cool, 4°C	28 days
Total alkalinity (as $CaCO_3$)	P,G	Yes	Cool, 4°C	7 days[(4)]
Total dissolved solids	P,G	Yes	Cool, 4°C	7 days
Total suspended solids	P,G	No	Cool, 4°C	7 days
Chloride	P,G	Yes	None required	28 days
Cyanide (total)	P,G	No	Cool, 4°C, NaOH to pH >12	12 days
Mercury	P,G	Yes	HNO_3 to pH<2	28 days
Nitrate as N	P,G	Yes	Cool, 4°C	2 days
Nitrite	P	No	Cool, 4°C	48 hours
Nitrate-Nitrite	P	No	H_2SO_4 to pH <2	28 days
Total Phosphorus	P,G	Yes	Cool, 4°C, H_2SO_4 to pH <2	28 days
Orthophosphate	P	Yes	Cool, 4°C	48 hours
Radionuclides (total)	P,G	No	HNO_3 to pH <2	6 months
Radionuclides (dissolved)	P,G	Yes	HNO_3 to pH <2	6 months
Silica	P	Yes	Cool, 4°C	28 days
Sulfate	P,G	Yes	Cool, 4°C	28 days
Dissolved metals[(5)]	P,G	Yes	Cool, 4°C, HNO_3 to pH <2	6 months
Total metals[(5)]	P,G	No	Cool, 4°C, HNO_3 to pH <2	6 months
Total recoverable metals	P,G	No	Cool, 4°C, HNO_3 to pH <2	6 months
Turbidity	P,G	No	Cool, 4°C	2 days

(1) Bottle code: P=polyethylene bottle with polyethylene-lined lid. G=glass bottle with Teflon-lined polyethylene lid.
(2) Samples requiring filtration must be filtered in the field using a 0.45 µm membrane filter before preservative is added.
(3) Holding times start at date of sample collection.
(4) Sample pH and alkalinity should be analyzed as soon as possible after collection. However, for practical purposes, the holding times have been set at seven days. The 14 day holding time specified in 40 CFR 136.3, Table II, is considered to be inappropriate for the high carbonate waters of the system.
(5) Metals in this category are listed the O&M Plan or Routine Monitoring Plan.

O&M SOP-8

SOP Date: May 2008

WATER TREATMENT PLANT SAMPLING

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard protocols for Water Treatment Plant sample collection for California Gulch CERCLA Site. This procedure is intended to be used together with other SOPs including:

- SOP 3 Field Instrument Calibration and Operation
- SOP 7 Sample Handling, Documentation, and Analysis

2.0 WATER TREATMENT PLANT SAMPLING

Water Treatment Plant sampling will collect samples from the following sample streams:

- Effluent
- Yak Tunnel
- Surge Pond
- Blockage

The effluent sample will be collected from the sample port on the pipe leading to outfall 001. The Yak Tunnel, Surge Pond, and blockage samples will be collected at the sample ports at the 1st stage tank.

These samples will be flow proportional composite samples. The composite sample shall, as a minimum, contain at least four (4) samples collected over the compositing period. Unless otherwise specified, the time between the collection of the first sample and the last sample shall not be less than six (6) hours nor more than 24 hours. Acceptable methods for preparation of composite samples are as follows:

a. Constant time interval between samples, sample volume proportional to flow rate at time of sampling;
b. Constant time interval between samples, sample volume proportional to total flow (volume) since last sample. For the first sample, the flow rate at the time the sample was collected may be used;
c. Constant sample volume, time interval between samples proportional to flow (i.e., sample taken every "X" gallons of flow); and,
d. Continuous collection of sample, with sample collection rate proportional to flow rate.

Sample streams will be pumping a minimum of six hours before sampling. Sample ports will be flushed approximately one minute before sample collection. The sample container will be triple rinsed only before the collection of the first aliquot. Subsequent aliquots will be placed in the sample container without rinsing. Samples will not be filtered. Sample handling, documentation, and labeling procedures are discussed in SOP 7.

Field parameters will be measured before the collection of the first aliquot only. Instrument calibration/check procedures are presented in SOP 3.

Field QA/QC samples will not be collected.

All sampling equipment is dedicated and decontamination will not be required.

O&M SOP-9

SOP Date: May 2008

SURGE POND STAFF GAUGE

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure for measuring water and sediment levels in the Surge Pond of the California Gulch CERCLA Site. This procedure gives descriptions of equipment and field procedures necessary to collect water level measurements.

2.0 WATER AND SEDIMENT LEVEL MEASUREMENT PROCEDURES

2.1 Equipment List

The equipment necessary to measure surge pond water levels includes:

- Field notebook
- Waterproof pen
- Rag for cleaning staff gradations
- Appropriate Health and Safety equipment

2.2 Procedures

The surge pond staff gauge is permanently installed on the walkway adjacent to the pump barge in the Surge Pond. The staff gauge has a white porcelain finish with readily visible black numeric gradations. The staff gauge is clearly visible from the pump barge.

The pond water level is read directly from the gauge. If the gradations on the gauge are difficult to read, use a rag to wipe off the gauge.

2.3 Documentation

Surge pond water levels observed on the staff gauge will be recorded in the field notebook. Volumes of pond water can be determined from Table 1. The pond water volumes will be recorded in the field notebook. Additional notes and observations are also recorded in the field notebook or on the daily Yak Water Treatment Plant form and shall include the time and date of readings and any unusual conditions observed.

Table 1 Staff Gauge Volume vs. Pond Volume

Staff Gauge Reading	Pond Volume	Staff Gauge Reading	Pond Volume	Staff Gauge Reading	Pond Volume	Staff Gauge Reading	Pond Volume	Staff Gauge Reading	Pond Volume
1.6	4,065,442	3.46	6,695,236	5.35	9,839,377	7.15	13,477,414	9.2	17,232,328
1.65	4,120,603	3.5	6,764,500	5.4	9,927,911	7.2	13,568,998	9.25	17,323,911
1.7	4,175,764	3.55	6,851,080	5.42	9,963,340	7.25	13,660,581	9.3	17,415,494
1.75	4,230,925	3.6	6,937,660	5.45	10,012,135	7.3	13,752,164	9.35	17,507,077
1.8	4,286,086	3.65	7,024,240	5.5	10,093,461	7.35	13,843,747	9.4	17,598,661
1.85	4,341,247	3.7	7,110,820	5.55	10,174,786	7.4	13,935,331	9.45	17,690,244
1.9	4,396,408	3.72	7,145,452	5.6	10,256,111	7.45	14,026,914	9.5	17,781,827
1.95	4,458,958	3.75	7,188,742	5.65	10,337,437	7.5	14,118,497	9.55	17,873,410
2	4,521,508	3.8	7,260,892	5.68	10,386,232	7.55	14,210,080	9.6	17,964,994
2.05	4,584,058	3.85	7,333,042	5.7	10,446,941	7.6	14,301,664	9.65	18,056,577
2.1	4,646,608	3.9	7,405,192	5.75	10,598,713	7.65	14,393,247	9.7	18,148,160
2.15	4,709,158	3.95	7,477,342	5.8	10,750,486	7.7	14,484,830	9.75	18,239,743
2.2	4,771,708	4	7,549,492	5.81	10,780,840	7.75	14,576,413	9.8	18,331,327
2.22	4,796,728	4.02	7,578,352	5.85	10,872,540	7.8	14,667,997	9.85	18,422,910
2.25	4,837,537	4.05	7,638,858	5.9	10,987,165	7.85	14,759,580	9.9	18,514,493
2.3	4,905,551	4.1	7,739,702	5.95	11,101,791	7.9	14,851,163	9.95	18,606,076
2.35	4,973,565	4.15	7,840,545	6	11,216,416	7.95	14,942,746	10	18,697,660
2.4	5,041,579	4.2	7,941,389	6.05	11,289,754	8	15,034,330	10.05	18,789,243
2.45	5,109,594	4.22	7,981,726	6.1	11,363,091	8.05	15,125,913	10.1	18,880,826
2.5	5,177,608	4.25	8,023,170	6.15	11,436,429	8.1	15,217,496	10.15	18,972,409
2.55	5,245,622	4.3	8,092,244	6.2	11,509,766	8.15	15,309,079	10.2	19,063,993
2.6	5,313,637	4.35	8,161,317	6.25	11,699,186	8.2	15,400,662	10.25	19,155,576
2.65	5,381,651	4.4	8,230,391	6.28	11,764,838	8.25	15,492,246	10.3	19,247,159
2.7	5,449,665	4.45	8,299,465	6.3	11,816,535	8.3	15,583,829	10.35	19,338,742
2.75	5,517,679	4.5	8,368,538	6.35	11,945,779	8.35	15,675,412	10.4	19,430,326
2.78	5,558,488	4.55	8,437,612	6.36	11,971,628	8.4	15,766,996	10.45	19,521,909
2.8	5,593,901	4.6	8,530,897	6.4	12,061,686	8.45	15,858,579	10.5	19,613,492
2.85	5,682,435	4.65	8,624,182	6.45	12,174,259	8.5	15,950,162	10.55	19,705,075
2.9	5,770,968	4.7	8,717,467	6.5	12,286,832	8.55	16,041,745	10.6	19,796,659
2.95	5,859,501	4.75	8,810,752	6.55	12,378,415	8.6	16,133,329	10.65	19,888,242
3	5,948,035	4.8	8,893,672	6.6	12,469,999	8.65	16,224,912	10.7	19,979,825
3.05	6,036,568	4.85	8,976,592	6.65	12,561,582	8.7	16,316,495	10.75	20,071,408

Table 1 Staff Gauge Volume vs. Pond Volume (continued)

3.1	6,125,043	4.9	9,059,512	6.7	12,653,165	8.75	16,408,078	10.8	20,162,992
3.15	6,213,519	4.95	9,142,432	6.75	12,744,748	8.8	16,499,662	10.85	20,254,575
3.2	6,301,994	5	9,225,352	6.8	12,836,332	8.85	16,591,245	10.9	20,346,158
3.22	6,337,384	5.05	9,312,418	6.85	12,927,915	8.9	16,682,828		
3.25	6,382,116	5.1	9,399,484	6.9	13,019,498	8.95	16,774,411		
3.3	6,456,668	5.15	9,486,550	6.95	13,111,081	9	16,865,995		
3.35	6,531,221	5.2	9,573,616	7	13,202,665	9.05	16,957,578		
3.4	6,605,773	5.25	9,662,190	7.05	13,294,248	9.1	17,049,161		
3.45	6,680,326	5.3	9,750,763	7.1	13,385,831	9.15	17,140,744		

O&M SOP-10

SOP Date: May 2008

FIELD QA/QC SAMPLES

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard protocols for sample handling, documentation, and analysis for California Gulch CERCLA Site. This procedure is intended to be used together with other SOPs and is referenced in all SOPs that apply to sampling.

All QA/QC samples will be collected following procedures presented in SOP 4 Ground Water Monitoring Well Sampling and SOP 6 Surface Water Sample Collection. This SOP applies to samples collected under the Routine Monitoring Plan and does not apply to samples collected monthly at the Yak Water Treatment Plant.

2.0 GROUNDWATER SAMPLING FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLES

The well sampling order will be dependent on expected levels of contamination in each well, if known, and will be determined prior to sampling. Quality assurance/quality control (QA/QC) samples will be collected during groundwater sampling.

QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses.

Field QA/QC samples consist of duplicates, rinsate blanks, and field blanks. The water quality sampling investigation will include collecting QA/QC samples at a minimum rate of 1 duplicate, 1 rinsate blank, and 1 field blank collected per sample event.

2.1 Rinsate Samples

An equipment rinsate sample of the sampling equipment is intended to check if decontamination procedures have been effective. For the well sampling operation, a rinsate sample will be collected from the decontaminated sampling equipment (bailer or pump) or filter equipment before it is used to obtain the sample. Deionized water will be rinsed over the decontaminated sampling apparatus and transferred to the sample bottles. The same parameters that are being analyzed in the groundwater samples will be analyzed in the rinsate samples. The rinsate sample is assigned a QA/QC sample identification number (SOP 7 Sample Handling, Documentation, and Analysis), stored in an iced cooler, and shipped promptly to the laboratory so that analyses can be performed within the holding times. Rinsate sample(s) will be collected at a minimum rate of 1 per every sample event.

2.2 Duplicate Samples

Duplicate samples are samples collected side-by-side to check for the natural sample variance and the consistency of field techniques and laboratory analysis. For groundwater sampling, a duplicate sample will be collected at the same time as the initial sample. The initial sample bottles for total metals and cyanide analyses will be filled first, then the duplicate sample bottles for total metals and cyanide and so on until all the necessary sample bottles for both the initial sample and the duplicate sample have been filled. The duplicate groundwater sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped promptly to the laboratory so that analyses can be performed within holding times. Duplicate samples will be collected at a minimum rate of 1 per every sample event.

2.3 Field Blanks

Field blanks check for contamination of samples due to factors at the well site. For a field blank, deionized water will be poured into the sample containers at the sample site at the same time the water sample is collected. The sample will be analyzed for the same parameters as the samples being collected with that blank. The sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory with the other samples. Field blank samples will be collected at a minimum rate of 1 per every sample event.

3.0 SURFACE WATER SAMPLING FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLES

Quality assurance/quality control (QA/QC) samples will be collected during surface water sampling. QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses.

Field quality assurance/quality control (QA/QC) samples consist of duplicates, rinsate blanks and field blanks. The water quality sampling investigation will include collection of the QA/QC samples at a minimum rate of one duplicate, one rinsate blank and one field blank collected per day or for every 20 samples per medium such that at least a rate of 5% of primary samples collected is achieved. For example, if from 1 to 20 primary samples are collected during a sampling episode, one each of a duplicate field blank and rinsate blank sample will be collected; if from 21 to 40 samples are collected during a sampling episode then two each of the QA/QC samples will be collected and so forth.

The 5% should be collected in such a method that they are representative of field condition variability, schedule/time of collection for the sampling event and sample teams. For example, if ambient conditions are altered that could impact sample quality, the frequency may be increased; QA/QC sampling should be conducted throughout the sampling event not just at the end.

3.1 Rinsate Samples

A decontamination rinsate sample of sampling equipment is intended to check is decontamination procedures have been effective. For the surface water sampling operation, a rinsate sample will be collected from the decontaminated sampling or filter equipment before it is used to obtain the sample. Deionized or distilled metal analyte-free water will be rinsed over a decontaminated sampling apparatus and transferred to the sample bottles. The same parameters that are being analyzed in the water samples will be analyzed in the rinsate samples. The rinsate sample is assigned a QA/QC sample identification number, stored in an iced cooler, and shipped to the laboratory. One rinsate sample will be collected at a minimum rate of one per day or one for every 20 water samples such that at least a rate of 5% of primary samples collected is achieved.

3.2 Field Duplicate Samples

Duplicate samples are samples collected side-by-side to check for the natural sample variance and the consistency of field techniques and laboratory analysis. For the surface water sampling a duplicate sample will be collected at the same time of the initial sample. One field duplicate will be collected at a minimum rate of per day or one for every twenty samples collected. The initial sample bottles for total metals analyses will be filled first, then the field duplicate sample bottles for total metals analyses, and so on until all necessary sample bottles for both the initial sample and the field duplicate sample have been filled. The field duplicate samples will be handled in the same manner as the primary sample. The field duplicate surface water samples will be assigned QA/QC identification numbers as described in SOP 10, subsection 2.1, Sample Identification, stored in a cooler containing either ice or blue ice, and shipped to the laboratory within a time frame allowing laboratory analysis within sample holding times.

3.3 Field Blanks

Field blanks check for contamination of samples due to factors at the sampling site or from the containers. For a field blank, a metals sample bottle is taken empty to the field and filled at the sampling site with organic-free deionized or distilled analyte-free water at the time the surface water is collected. The sample will be assigned a QA/QC identification number, stored in an iced or blue ice cooler, and shipped to the laboratory with the other samples. One field blank will be collected at a minimum rate of one per day or one for every 20 water samples such that at least a rate of 5% of primary samples collected is achieved.

O&M SOP-11

SOP Date: May 2008

WATER LEVEL MEASUREMENT USING PRESSURE TRANSDUCERS

1.0 PURPOSE AND SCOPE

The purpose of this document is to define the standard procedure applicable to the use of pressure transducer and datalogger equipment for measuring water levels at the California Gulch CERCLA Site. This SOP describes the equipment and field procedures that are required for collection of water level measurements. This SOP is intended to be used together with manufacturer's manuals and other SOPs. SOP No. 1 describes decontamination procedures that are applicable to this SOP. SOP 2 describes manual water level measurement procedures. This SOP does not apply to the pressure transducer installed in the Yak Tunnel Bulkhead, see the O&M Plan for the Yak Tunnel Bulkhead for specific procedures for that transducer.

2.0 WATER LEVEL MEASUREMENT PROCEDURES

This SOP was prepared for use with In-Situ pressure transducer/data loggers. These In-Situ instruments are the MiniTROLL, TROLL 4000, and the Level TROLL 500. Each instrument requires a different version of software to download data and its own communications cable. The MiniTROLL requires Win-Situ 4, the TROLL 4000 requires Win-Situ 2000 and the Level TROLL 500 requires Win-Situ 5. In-Situ operation manuals for the transducers and software should be referred to for operational procedures and can be found at http://www.in-situ.com/.

Transducers should be programmed to read in feet, top of casing mode (positive down), and be referenced to the water level such that a decrease in water level results in an increase in depth to water from the reference point.

2.1 Equipment List

The equipment necessary to install, download, or remove the pressure transducer, data cable, and datalogger includes:

- Pressure transducer/data logger and vented data cable with cable hanger (Kellems Grip)
- Appropriate wrenches and tools
- RS-232 data transfer cable for the specific tranducer/datalogger
- Transducer/Datalogger and software manual
- Field microcomputer with serial port
- Microcomputer compatible magnetic data storage diskettes
- Electric water level indicator capable of producing measurements to a precision of 0.01 ft
- Field data sheets for manual water level measurement
- Field notebook

- Garden-type sprayer filled with deionized or distilled water
- Paper or cloth towels
- Appropriate health and safety equipment

2.2 Installation and Removal of Equipment

This section gives the sequence of events that should be followed when measuring water levels.

Appropriate health and safety equipment, as described in the Site Health and Safety Plan, should be worn during well opening, well measurement, and decontamination.

2.2.1 Equipment Installation

The following procedure describes the steps that need to be followed to assure that the datalogger/pressure transducer equipment is correctly installed in the piezometer:

1. The locking steel protective cap and vented well cap are removed.
2. The plastic cover of the data cable reel is removed and the pressure transducer and cable are inspected for damage or contamination.
3. The transducer end of the cable is placed in the well and the cable is unreeled into the well to the full length of the cable.
4. The RS-232 cable is attached to link the computer to the top of the logger. Communication is established with the transducer/data logger using In-Situ software.
5. The logger status is checked using the logger communications software. The readings are evaluated to ensure that the equipment is operating correctly.
6. With the data cable and pressure transducer in the well, a manual water level measurement is made following SOP No. 2 and the reading is recorded in the field notebook and on a water level measurement data sheet.
7. The locking protective cap is put in place and locked. Any necessary documentation is completed.

2.2.2 Equipment Removal

The following procedure describes the steps required for proper removal of the datalogger/pressure transducer equipment from the piezometer.

1. The locking cap is removed. The support cap, support cable and transducer/datalogger are withdrawn from the well casing and secured.
2. The transducer/datalogger is attached to the field computer by the RS-232 cable and the data are downloaded to a designated computer file following procedures described in the datalogger manual.
3. The data are examined using the computer to determine if the equipment has been operating properly. If no operational problems are identified the data file is backed up on a magnetic computer disk, the logger is stopped, and communications ended.

2.3 Downloading Data

Data collected by the datalogger during stand-alone operation can be transferred to a computer file in the field The In-Situ Instruction Manual describes the downloading process and other communication procedures in detail.

2.4 Decontamination

The datalogger and pressure transducer equipment must be decontaminated before installation, and after removal from the piezometer.

The datalogger, pressure transducer, and data cable will be decontaminated following the sensitive equipment procedure described in SOP No. 1. The equipment will be rinsed with deionized or distilled water prior to installation. When the transducer/datalogger is removed it will be wiped down using a clean rag to remove excess moisture and obvious rust or dirt as the equipment is being recovered from the well. Each datalogger and pressure transducer assembly is dedicated to a specific piezometer; therefore, the equipment does not need to be thoroughly decontaminated in accordance with SOP No. 1 except when it may have contacted a contaminated surface during removal from the well. The equipment will be stored in clean plastic bags whenever it is not in the well.

2.5 Documentation

This section describes the documentation necessary for water level measurement using pressure transducers.

In general, the documentation requirements for water level measurements collected using pressure transducers are the same as those that apply to water level measurements collected manually. These requirements, described in SOP No. 2, include the completion of a field data sheet during each measuring event. The field data sheet will include date, time, well number, water level, and static water elevation data. A field notebook will also be used for recording both manual and pressure transducer datalogger water level measurement activities, for describing decontamination, calibration, and monitoring procedures, and for recording other observations. Both the data sheets and notebook should be neat and legible, and will be signed and dated by the person completing each page.

The following information will be recorded in the field notebook to document datalogger field operations:

- Arrival time at well
- Data and time of manual water level measurement
- Results of examination of equipment
- The record number of the most recent transducer reading
- The head value of that record and the temperature reading
- The computer file name
- Any repairs made to the equipment
- Transducer battery voltage
- Observations of the weather and condition of the well

- Notes about the quality of the data or any problems that have been identified
- Whether the memory of the instrument or any recording parameters have been reset
- Time of replacing the equipment in the well.

3.0 DATA CORRECTIONS

Each time the datalogger is installed, removed or downloaded, field personnel must compare the depth to water measured manually with the reading recorded by the datalogger. This is necessary because the pressure transducer readings are subject to drift over time and the data cable may tend to stretch with time. The comparison of the manual and transducer readings provides a means of correcting for the combined "drift" of the logger data. Return transducer to manufacturer for recalibration if unusual data is noted.

APPENDIX B
TO OU1 WORK PLAN
MONTHLY PROGRESS REPORT FORMAT

Date

Name
Title
Entity
Address
Address

Subject: OU1 Work Plan Monthly Report, Yak Tunnel Operable Unit, California Gulch Site

Dear Name:

This letter presents the DATE___ Monthly Report regarding the Yak Tunnel Operable Unit Remedial Design/Remedial Action for the above referenced OU1 Work Plan. This report is submitted as required by Section 5.8 of the OU1 Work Plan.

1. <u>Description of the actions taken pursuant to the OU1 Work Plan:</u>

-Cumulative volume of water pumped from blockage
-Water levels behind blockage
-Water levels behind bulkhead

2. <u>Describe work completed at the Water Treatment Plant:</u>

Water Treatment Plant Operations including:

-Chemicals used
-Monthly daily maximum and minimum flow rates of influent by source
-Total gallons of influent and effluent

Water Treatment Plant Effluent Quality:

Water Treatment Plant Sludge,

-Amount of hazardous and non-hazardous sludge shipped offsite and amount stored onsite:

Maintenance:

3. <u>Activities that deviated from the OU1 Work Plan:</u>

4. <u>Summaries of all changes made in the OU1 facilities during the month:</u>

5. <u>Unresolved problems or potential problems encountered during the month that may cause a performance delay:</u>

6. <u>Changes in personnel during the reporting period:</u>

7. Projected work for next reporting period includes:

8. Results of sampling, tests and other data received or produced:

9. Is tri-annual electronic transmittal of RMP data attached:
___Yes or ___No

10. If the tri-annual data transmittal was attached, was there any determination under the CP during the prior month that enhanced monitoring or additional investigations are required, or that an adverse water condition or hydraulic gradient reversal has occurred:

Yak Tunnel Water Treatment Plant
Water Analysis Summary
DATE

LABORATORY PARAMETER	INFLUENT ANALYSIS															
	GIL				SPIL				BIL				Mixed Influent			
	Result (mg/l)	Qualifier	PQL/RL (mg/l)	Adjusted Result (mg/l)	Result (mg/l)	Qualifier	PQL/RL (mg/L)	Adjusted Result (mg/L)	Result (mg/l)	Qualifier	PQL/RL (mg/L)	Adjusted Result (mg/L)	Weighted Avg Flow Conc (mg/L)	Weighted Max Flow Conc (mg/L)	Avg (lbs/Day)	Max (lbs/Day)
Aluminum (AS)																
Arsenic (TR)																
Cadmium (TR)																
Chromium (TR)																
Copper (TR)																
Iron (TR)																
Lead (TR)																
Manganese (TR)																
Mercury (TR)																
Selenium (TR)																
Silver (TR)																
Zinc (TR)																
Solids (TSS)																
Calcium																
Magnesium																
Hardness (calc)																

FIELD PARAMETERS	GIL				SPIL				BIL			
	Min	Max	Avg	Total Million Gal	Min	Max	Avg	Total Million Gal	Min	Max	Avg	Total Million Gal
Cond. - uS/cm												
pH (su)												
Flow (MGD)												

0

Yak Tunnel Water Treatment Plant

Water Analysis Summary

DATE

LABORATORY PARAMETER	EFFLUENT ANALYSIS									
	Result (mg/L)	Qualifier	PQL/RL (mg/L)	Adjusted Result (mg/L)	Avg Discharge Limit (mg/L)	Max Discharge Limit (mg/L)	Avg (lbs/Day)	Avg Discharge Limit (lbs/Day)	Max (lbs/Day)	Max Discharge Limit (lbs/Day)
Aluminum (AS)										
Arsenic (TR)										
Cadmium (TR)					**0.050**	**0.100**				
Chromium (TR)										
Copper (TR)					**0.150**	**0.300**				
Iron (TR)										
Lead (TR)					**0.300**	**0.500**				
Manganese (TR)										
Mercury (TR)					**0.001**	**0.002**				
Selenium (TR)										
Silver (TR)										
Zinc (TR)					**0.750**	**1.500**				
Solids (TSS)					**20**	**30**		**240**		**360**
Calcium										
Magnesium										
Hardness (calc)										

FIELD PARAMETERS	EFFLUENT					
	Min	Min Discharge Limit	Max	Max Discharge Limit	Avg	Total Million Gal
Cond. - uS/cm						
pH (su)						
Flow (MGD)						

CHEMICAL USAGE	Start of Month (lbs)	Received (lbs)	End of Month (lbs)	Used (lbs)	Approx. Dosage (mg/L)
Hydrated Lime					
Sulfuric Acid					
Polymer					

Yak Tunnel Water Treatment Plant

Daily Flow Data

DATE

Date	Start Time	End Time	Hours of Operation	Discharge for Day
Month/Day/Year				
Month/Day/Year				
Month/Day/Year				
Month/Day/Year				
Month/Day/Year				
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Month/Day/Year				
Month/Day/Year				
Month/Day/Year				
Month/Day/Year				

Total for Month 0

APPENDIX C

TO OU1 WORK PLAN

DISCHARGE MONITORING REPORT (DMR) FORMAT

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO

ADDRESS CALIFORNIA GULCH-YAK TUNNEL
PO BOX 1210
LEADVILLE CO 80461

FACILITY

LOCATION

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR
M - INTERIM
DISCHARGE - Yak Tunnel WTP

MONITORING PERIOD		
FROM mm/dd/yy	TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
FLOW	SAMPLE MEASUREMENT			MGD	*****	*****	*****		0	DAILY	CONT
'74076 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT		*****	*****	*****			DAILY	CONT
pH	SAMPLE MEASUREMENT	*****	*****			*****		SU	0	DAILY	CONT
'00400 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		6.00	*****	9.00			DAILY	CONT
SOLIDS, SUSPENDED TOTAL	SAMPLE MEASUREMENT			LBS	*****			mg/l	0	1	COMP
'00530 100 EFFLUENT	PERMIT REQUIREMENT	240	360	PER DAY	*****	20	30			1 X MONTH	COMP
ALUMINUM ACID SOL.	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'85824 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
ARSENIC TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'00978 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
CADMIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01113 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	50	100			1 X MONTH	COMP
CHROMIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01033 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP

NAME/TITLE PRINCIPAL OFFICER

Name
Title
Resurrection Mining Co

TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE

DATE

COMMENT AND EXPLANATION OF ANY VIOLATIONS (REFERENCE ALL ATTACHMENTS HERE)

PAGE 1 OF 7

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO

ADDRESS CALIFORNIA GULCH-YAK TUNNEL

PO BOX 1210

LEADVILLE CO 80461

FACILITY

LOCATION

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR

M - INTERIM

DISCHARGE - Yak Tunnel WTP

MONITORING PERIOD			
FROM mm/dd/yy	TO	mm/dd/yy	

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
COPPER TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01119 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	150	300			1 X MONTH	COMP
IRON TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'00980 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
LEAD TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01114 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	300	500			1 X MONTH	COMP
MANGANESE TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'11123 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
MERCURY TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	
'71901 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	1	2			1 X MONTH	COMP
SELENIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'00981 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
SILVER TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01079 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP

NAME/TITLE PRINCIPAL OFFICER

Name
Title
Resurrection Mining Co

TYPED OR PRINTED

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE 303 237-5852

DATE

COMMENT AND EXPLANATION OF ANY VIOLATIONS (REFERENCE ALL ATTACHMENTS HERE)

PAGE 2 OF 7

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO

ADDRESS CALIFORNIA GULCH-YAK TUNNEL

PO BOX 1210

LEADVILLE CO 80461

FACILITY

LOCATION

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR

M - INTERIM

DISCHARGE - Yak Tunnel WTP

	MONITORING PERIOD		
FROM	mm/dd/yy	TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
ZINC TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l	0	1	COMP
'01094 100 EFFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	750	1500			1 X MONTH	COMP
CALCIUM TOTAL	SAMPLE MEASUREMENT	*****	*****		*****			mg/l	0	1	COMP
'00916 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			1X MONTH	COMP
MAGNESIUM TOTAL	SAMPLE MEASUREMENT	*****	*****		*****			mg/l	0	1	COMP
'00927 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			1X MONTH	COMP
HARDNESS TOTAL	SAMPLE MEASUREMENT				*****			mg/l	0	1	CALC
'00900 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			1X MONTH	CALC
OIL & GREASE Visual	SAMPLE MEASUREMENT	*****	*****		*****			Yes=1 No=0	0	DAILY	VIS
'84066 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			DAILY	VIS
OIL & GREASE Contingent	SAMPLE MEASUREMENT	*****	*****		*****			mg/l	0	CNTGT	GRAB
'84066 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			CNTGT	GRAB
	SAMPLE MEASUREMENT	*****	*****		*****			mg/l			
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT				

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Name Title Resurrection Mining Co	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE DATE
TYPED OR PRINTED			

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PAGE 3 OF 7

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO

ADDRESS CALIFORNIA GULCH-YAK TUNNEL
PO BOX 1210
LEADVILLE CO 80461

FACILITY

LOCATION

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR
M - INTERIM
DISCHARGE - Yak Tunnel WTP

MONITORING PERIOD			
FROM mm/dd/yy		TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
48 HOUR ACUTE CERIODAPHANIA	SAMPLE MEASUREMENT	*****	*****		*****			PASS=0	0	1	COMP
TGM3B 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT	FAIL=1		SEMI-ANNUAL	COMP
96 HOUR ACUTE FATHEAD MINNOWS	SAMPLE MEASUREMENT	*****	*****		*****			PASS=0	0	1	COMP
TGN6C 100 EFFLUENT	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT	FAIL=1		SEMI-ANNUAL	COMP
	SAMPLE MEASUREMENT	*****	*****		*****	*****	*****				
	PERMIT REQUIREMENT	*****	*****		*****	*****	*****				
	SAMPLE MEASUREMENT	*****	*****		*****	*****	*****				
	PERMIT REQUIREMENT	*****	*****		*****	*****	*****				
	SAMPLE MEASUREMENT	*****	*****		*****	*****	*****				
	PERMIT REQUIREMENT	*****	*****		*****	*****	*****				
	SAMPLE MEASUREMENT	*****	*****		*****	*****	*****				
	PERMIT REQUIREMENT	*****	*****		*****	*****	*****				
	SAMPLE MEASUREMENT	*****	*****		*****	*****	*****				

NAME/TITLE PRINCIPAL OFFICER			
Name Title Resurrection Mining Co	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.		TELEPHONE [illegible]
TYPED OR PRINTED		SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	DATE

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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO

ADDRESS CALIFORNIA GULCH-YAK TUNNEL
PO BOX 1210
LEADVILLE CO 80461

FACILITY

LOCATION

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR
M - INTERIM
DISCHARGE - Yak Tunnel WTP

MONITORING PERIOD			
FROM mm/dd/yy		TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
FLOW	SAMPLE MEASUREMENT			MGD	*****	*****	*****			DAILY	CONT
'74076 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT		*****	*****	*****			DAILY	CONT
pH	SAMPLE MEASUREMENT	*****	*****			*****		SU		DAILY	CONT
'00400 G00 INFLUENT	PERMIT REQUIREMENT	*****	*****		REPORT	*****	REPORT			DAILY	CONT
SOLIDS, SUSPENDED TOTAL	SAMPLE MEASUREMENT			LBS	*****			mg/l		1	COMP
'00530 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
ALUMINUM ACID SOL.	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'85824 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
ARSENIC TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'00978 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
CADMIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'01113 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1X MONTH	COMP
CHROMIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'01033 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP

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Name
Title
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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

PERMITTEE NAME/ADDRESS

NAME RES-ASARCO
ADDRESS CALIFORNIA GULCH-YAK TUNNEL
PO BOX 1210
LEADVILLE CO 80461

FACILITY
LOCATION

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR
M - INTERIM
DISCHARGE - Yak Tunnel WTP

MONITORING PERIOD			
FROM	mm/dd/yy	TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
COPPER TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'01119 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
IRON TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'00980 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
LEAD TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'01114 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
MANGANESE TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'11123 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
MERCURY TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'71901 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
SELENIUM TOTAL REC	SAMPLE MEASUREMENT			LBS	*****			ug/l		1	COMP
'00981 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP
SILVER TOTAL REC	SAMPLE MEASUREMENT	0	0	LBS	*****			ug/l		1	COMP
'01079 G00 INFLUENT	PERMIT REQUIREMENT	REPORT	REPORT	PER DAY	*****	REPORT	REPORT			1 X MONTH	COMP

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Name
Title
Resurrection Mining Co
TYPED OR PRINTED

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SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE 303-637-5852
DATE

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PERMITTEE NAME/ADDRESS

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

NAME RES-ASARCO
ADDRESS CALIFORNIA GULCH-YAK TUNNEL
PO BOX 1210
LEADVILLE CO 80461

COU000099	001' A
PERMIT NUMBER	DISCH NUMBER

MAJOR
M - INTERIM
DISCHARGE - Yak Tunnel WTP

FACILITY
LOCATION

	MONITORING PERIOD		
FROM	mm/dd/yy	TO	mm/dd/yy

PARAMETER		QUANTITY OR LOADING			QUALITY OR CONCENTRATION				NO. EX	FREQUENCY OF ANALYSIS	SAMPLE TYPE
		AVERAGE	MAXIMUM	UNITS	MINIMUM	AVERAGE	MAXIMUM	UNITS			
ZINC TOTAL REC '01094 G00 INFLUENT	SAMPLE MEASUREMENT			LBS PER DAY	*****			ug/l		1	COMP
	PERMIT REQUIREMENT	REPORT	REPORT		*****	REPORT	REPORT			1 X MONTH	COMP
CALCIUM TOTAL '00916 G00 INFLUENT	SAMPLE MEASUREMENT	*****	*****		*****			mg/l		1	COMP
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			1X MONTH	COMP
MAGNESIUM TOTAL '00927 G00 INFLUENT	SAMPLE MEASUREMENT	*****	*****		*****			mg/l		1	COMP
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			IX MONTH	COMP
HARDNESS TOTAL '00900 G00 INFLUENT	SAMPLE MEASUREMENT	*****	*****		*****			mg/l		1	CALC
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			IX MONTH	CALC
OIL & GREASE Visual '00556 G00 INFLUENT	SAMPLE MEASUREMENT	*****	*****		*****			Yes=1 No=0		DAILY	VIS
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			DAILY	VIS
OIL & GREASE Contingent '84066 100 EFFLUENT	SAMPLE MEASUREMENT	*****	*****		*****			mg/l		CNTGT	GRAB
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT			CNTGT	GRAB
	SAMPLE MEASUREMENT	*****	*****		*****						
	PERMIT REQUIREMENT	*****	*****		*****	REPORT	REPORT				

NAME/TITLE PRINCIPAL OFFICER			
Name Title Resurrection Mining Co TYPED OR PRINTED	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE DATE

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APPENDIX D
TO OU1 WORK PLAN
ROUTINE MONITORING PLAN

APPENDIX D
TO OU1 WORK PLAN

2008 ROUTINE MONITORING PLAN
YAK TUNNEL OPERABLE UNIT
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO
MAY 2008

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1.0 INTRODUCTION

This Routine Monitoring Plan (RMP), Contingency Plan (CP) (MFG, 2008a) and the OU1 Work Plan (Work Plan) (MFG, 2008b) govern the long-term implementation of the selected remedy for the Yak Tunnel Operable Unit (OU1), California Gulch Superfund Site, Leadville, Colorado, in accordance with the terms of the Consent Decree by and among the United States, State of Colorado, Newmont USA Limited and Resurrection Mining Company, to which the OU1 Work Plan and this RMP are appended. The purpose of the RMP is to collect the appropriate type, amount, and quality of data needed to support the decision-making in the CP. These decision-making steps are illustrated in Figure 1 and discussed in detail in the CP. The RMP describes the objectives of the monitoring program, monitoring points and parameters, sampling and laboratory methods, quality assurance procedures, data evaluation methods, and reporting requirements to be implemented during the routine monitoring mode of operation of the CP. This Plan is incorporated into the Work Plan by reference.

1.1 Objectives

The general objectives of the RMP are to:

- Provide information on current conditions of the Yak Tunnel Hydrologic System, and compare current conditions to all previously recorded conditions
- Provide information on changes that may occur in the Yak Tunnel Hydrologic System
- Provide information to support decisions regarding the need for enhanced monitoring activities, additional investigations, and the need for response actions, and
- Document the effectiveness of response actions that have been implemented.

These objectives assure that the six decision steps described in the CP can be made effectively and defensibly. In particular, routine monitoring consists of the recording of conditions of the Yak Tunnel Hydrologic System over time, to allow assessment of any significant changes of conditions. As described in detail in the CP, the major decisions related to data evaluation are: (a) whether hydraulic gradient reversal away from the Yak Tunnel has occurred, and (b) whether adverse water quality conditions exist. (See Table 1 of the CP).

This RMP includes monitoring revisions that have been implemented since the issuance of the Routine Monitoring Plan Revision 1 (MFG, 1999). Those revisions reflect changes that have occurred between 1991, when the initial phase of routine monitoring began, and 1999. It also reflects current conditions within the Yak Tunnel Hydrologic System. Changes to and current conditions of the Yak Tunnel include:

- Construction of the Yak Tunnel bulkhead in 1994
- Cessation of mining activities and dewatering of the Black Cloud Mine in 1999

- Formation of a blockage in the Yak Tunnel in approximately 2002
- Beginning of remedial pumping of blockage water beginning in 2006

1.2 Routine Monitoring Plan Organization

Section 1 presents the overall purpose and objectives of the RMP. Section 2 presents monitoring and evaluation requirements to ensure that the relevant hydrologic conditions within OU1 are adequately documented, and the information necessary for the CP decision-making processes is generated. Section 3 contains the sampling and analytical methods which will be employed during monitoring activities. The data quality review, data evaluation, and data management procedures are discussed in Section 4. Procedures for systematically reviewing additional data and revising the monitoring plan are discussed in Section 5. Section 6 discusses the reporting requirements for the routine monitoring program. References are presented in Section 7. The terms used in this Routine Monitoring Plan shall have the same definition as that provided in the Work Plan and Contingency Plan.

2.0 ROUTINE MONITORING REQUIREMENTS

The routine monitoring program is designed to collect adequate data regarding the conditions of the Yak Tunnel Hydrologic System to support decision-making in the CP. Data collected during routine monitoring is evaluated along with all previously recorded data to determine the current state of the Yak Tunnel Hydrologic System and what, if any, changes to the Yak Tunnel Hydrologic System have occurred. Following is a discussion of the monitoring locations, parameters, and frequencies which will be incorporated into the routine monitoring program. The monitoring requirements discussed in this section are summarized in Table 1. Sampling, monitoring, and analytical methods will be discussed in Section 3.

2.1 Monitoring Locations

Monitoring locations were established during previous investigations, including the Draft RMP (Baker, 1993), Routine Monitoring Plan Revision 1 (MFG, 1999), and Additional Investigation Work Plan (MFG, 2004). Parameters monitored have been revised from those established in the Routine Monitoring Plan Revision 1 (MFG, 1999). Monitoring locations that comprise the routine monitoring program remain unchanged from those previously monitored with the exception of the exclusion of the 1330 Lateral as a monitoring point. Locations and monitoring activities to evaluate the Yak Tunnel Hydrologic System are discussed below and include the Yak Tunnel Bulkhead/Treatment Plant, Yak Tunnel blockage pumping system, piezometers and monitoring wells, and springs/seeps. Monitoring locations are summarized in Table 1 and shown on Figure 2.

2.2 Parameters

Parameters that will be monitored under the routine monitoring program are listed on Table 1. These parameters will be used for: (1) ongoing characterization of potential short- and long-term natural variability; and (2) interpretation of significant departures from previously recorded conditions, should they occur. The parameters are used to assess conditions in the Yak Tunnel Hydrologic System to support the decision making process of the CP. Data collected pursuant to the RMP will allow for ongoing evaluation during the Routine Monitoring Mode of Operation (RMM) of whether a hydraulic gradient reversal has occurred, or adverse water conditions resulting from changes within the tunnel system exist. To provide that information, the parameters routinely monitored include:

- Water level elevation behind the Yak Tunnel bulkhead
- Yak Tunnel flow rates and select field water quality parameters
- Yak Tunnel blockage pumping rates
- Water level elevations in monitoring wells
- Water level elevations in mine shafts
- Piezometer and monitoring well field parameter and water quality measurements
- The occurrence, surface elevation, flow rate, and water quality of any newly-observed seeps and springs

2.3 Details of Routine Monitoring Program at the Various Locations

This section details the routine monitoring program at various locations and the rational for the use of these monitoring locations and parameters. A summary of the routine monitoring program, including monitoring locations, general parameters, and sampling frequency, is provided in Table 1.

2.3.1 Yak Tunnel Bulkhead and Flow Rates

The Yak Tunnel water data that will be monitored include bulkhead water levels, flow rates through the bulkhead, and water quality of the Yak Tunnel discharge. A description of these monitoring details is provided in Section 5.3 of the Work Plan. The water level behind the bulkhead will be compared to water levels in Yak Tunnel Hydrologic System monitoring wells to assess the potential of a gradient reversal and to determine whether an adverse water condition exists. The Yak Tunnel flow rate is measured daily at the Gravity Influent Line (GIL). Under current conditions, the Yak Tunnel flow rate at the bulkhead does not represent free-flowing conditions since water is impounded behind the bulkhead and the blockage. However, bulkhead water level elevations can be compared to groundwater elevations. The quality of the Yak Tunnel water is a product of numerous physical and chemical processes which vary seasonally and with the water level behind the bulkhead. It is important to characterize the Yak Tunnel water quality to determine baseline conditions and for comparison to the water quality at the other monitoring locations. However, other monitoring locations and parameters would be more responsive to tunnel blockage or changes in the Yak Tunnel Hydrologic System; therefore, the

Yak Tunnel flow rate and field and water quality parameters will not be considered parameters in the CP decision-making process.

The water level behind the bulkhead is monitored by either a pressure transducer or a sonic level device, and recorded daily. The Yak Tunnel flow rate is recorded once daily during treatment plant operation. Field parameters are measured daily according to the Work Plan.

2.3.2 Yak Tunnel Blockage Pumping Rate, Water Levels and Water Quality

As described in Section 5.4 of the Work Plan, the water flowing to the Yak Tunnel WTP will be continuously monitored at the Blockage Influent Line (BIL) when water is being pumped from the Yak Tunnel blockage. The pumping rate will be recorded once daily. Groundwater levels in the Black Cloud, Irene, and Helena shafts will be measured daily using pressure transducers and recorded by data loggers, as described below in Section 2.3.3.2. Water quality sampling will occur semi-annually (twice a year) within the Yak Tunnel blockage mine water, as described below in Section 2.3.3.3.

2.3.3 Bedrock Groundwater Monitoring

2.3.3.1 Description of the Monitoring Network

The OU1 monitoring network includes monitoring wells BBW-1, BBW-2, BBW-3, BBW-4, BBW-5 and BBW-10, and piezometers BBW-7 and BBW-8. The locations of the BBW wells and piezometers are shown on Figure 2, and the well/piezometer construction details are provided in Table 2. Monitoring wells BBW-1, BBW-2, BBW-3, BBW-4 and BBW-10 are located along faults known or thought to communicate hydraulically with the Yak Tunnel. Wells BBW-1 and BBW-2 are located on either side of the Yak Tunnel in the Pilot Fault, and are screened in gray porphyry. Wells BBW-3 and BBW-4 are located on either side of the Yak Tunnel in the Weston Fault. Well BBW-3 is screened in quartzite and gray porphyry, and well BBW-4 is screened in gray porphyry. Well BBW-10 is located in upper Evans Gulch along an assumed extension of the Silent Friend Fault, and is screened in quartzite. Monitoring well BBW-5 and piezometer BBW-8 are completed in extensively mined areas near the Yak Tunnel. BBW-5 is screened in quartzite and is located approximately 16,200 feet from the Yak Tunnel portal. BBW-8 is completed in backfilled or collapsed mine workings near the Yak Tunnel approximately 5,630 feet from the portal. Piezometer BBW-7 is located west of the

Iron/Mikado/Emmett Fault complex, between the Yak Tunnel portal and the bulkhead. BBW-7 is completed in the Pando porphyry.

Water level measurements from BBW-1, BBW-2, BBW-3, BBW-4, BBW-7, and BBW-10 have been used primarily to document the seasonal groundwater elevation variations in the local groundwater system near the Yak Tunnel. Water level data from BBW-5 and BBW-8 are primarily used to document hydraulic conditions within the Yak Tunnel. The hydraulic gradient in bedrock groundwater in the vicinity of the Yak Tunnel is evaluated by comparing water levels in wells BBW-1, BBW-2, BBW-3, BBW-4 and BBW-10 to water levels in piezometers BBW-5 and BBW-8.

In addition, groundwater monitoring also occurs at the Irene Shaft (the replacement monitoring location for the 1330 Lateral), the Black Cloud Shaft, and the Helena Shaft. These data provide information regarding groundwater conditions behind the Yak Tunnel blockage. This water is hydraulically connected to the Yak Tunnel via the 1330 Lateral.

2.3.3.2 Groundwater Level Monitoring

Groundwater elevations serve to assess groundwater gradients and other conditions within the Yak Tunnel Hydrologic System. Indication of a reversal of hydraulic gradient away from the Yak Tunnel or significant changes in groundwater elevations may result in a YES response to Decision 3 of the CP and thereby trigger additional response actions or a revision to the routine monitoring program. As groundwater elevation data is collected, the data will be compared to all previously recorded data to assess natural variability of the hydraulic system and to determine if significant changes have occurred.

The water levels in BBW-5, BBW-8, Black Cloud Shaft and Irene Shaft provide a direct indication of water level elevations in the Yak Tunnel and Yak Tunnel blockage pool. Storage of water behind the bulkhead or blockage within the tunnel between the bulkhead and BBW-8 should be observed in piezometer BBW-8 due to the hydraulic connection between this piezometer and the tunnel. A blockage upgradient of BBW-8 area should be observed by an increase in the water level in BBW-5 and the Black Cloud and Irene shafts. The effects of a blockage on water levels will depend upon the magnitude of the blockage and the distance between the blockage and the groundwater monitoring point. Due to the extensive mine workings, blockages within other areas of the Yak Tunnel may not be obvious since the groundwater may be re-routed though the mine workings into the tunnel. Water level changes may be observed in the other wells and piezometers; however, it is expected that the water levels in BBW-5, BBW-8 or at the Black Cloud or Irene mine shafts would respond more quickly to tunnel blockage. Nonetheless, water levels in wells BBW-1, BBW-2, BBW-3, BBW-4 and BBW-10 will be monitored because of their use in evaluating a potential gradient reversal. Water levels in BBW-7 are also considered because they provide information regarding the extent to which the Iron/Mikado/Emmett fault complex inhibits westward groundwater flow at the Yak Tunnel. However, these data are not considered suitable for calculating hydraulic gradients for purposes of determining a hydraulic gradient reversal because water levels in BBW-7 are naturally lower than water levels in the Yak Tunnel Hydrologic System.

Groundwater levels in all BBW wells and piezometers, and the Irene and Helena shafts, will be measured weekly using pressure transducers and recorded by data loggers, with the exception of BBW-1 and BBW-2, which do not have pressure transducers installed and will be manually measured at least quarterly during spring, summer, and fall with an electric water level indicator. Groundwater levels in the Black Cloud shaft will be measured daily using pressure transducers and recorded by data loggers. Downloading of data loggers and manual water level measurements will occur tri-annually at all wells, piezometers, and mine shafts during the spring, summer, and fall seasons.

2.3.3.3 Groundwater Quality Monitoring

Groundwater quality data will be used to assess groundwater conditions in the Yak Tunnel Hydrologic System, and whether adverse water conditions exist. As with the hydraulic gradient reversal discussed above, a finding of adverse water conditions will result in a YES response to Decision 3 of the CP. The primary parameters to assess water quality changes within the Yak Tunnel Hydrologic System are pH and specific conductance. A gradient reversal away from the Yak Tunnel may result in significant changes in pH or higher specific conductance in the groundwater entering the wells. The pH and specific conductance change would depend upon the magnitude of the gradient reversal, residence time of the water prior to reaching the wells, and the nature of geochemical interactions between groundwater and geologic materials. Other water quality parameters, including dissolved metals, major cations, general chemical constituents, and total and dissolved solids, will also be monitored. As with pH and specific conductance, data for these parameters will be compared with all previously collected data to evaluate natural variability of the hydrologic system, and to determine whether any significant changes have occurred. As indicated in Table 3, parameters that will be used for characterization of water quality include general chemical constituents (total alkalinity and total dissolved solids), major inorganic constituents (calcium, chloride, magnesium, potassium, sodium, silica, and sulfate) and dissolved metals (aluminum, arsenic, cadmium, copper, iron, lead, manganese, nickel and zinc).

Water quality sampling will occur semi-annually (twice a year) at monitoring wells BBW-5 and BBW-10, and within the Yak Tunnel blockage mine water. The blockage mine water can be sampled directly from either the Black Cloud or Irene mine shafts, or while pumping of blockage water is occurring, from the sampling port on the BIL at the Yak Tunnel WTP. Water quality sampling of monitoring wells BBW-1, BBW-2, BBW-3, and BBW-4 will occur once every five years beginning in 2010. Previous sampling events occurred in 1995, 2000, and 2005. Water quality sampling of the GIL will be performed according to the Work Plan.

2.3.3.4 Springs/Seeps

The emergence of new springs or seeps on the south side of Iron Hill or other areas may indicate that Yak Tunnel water level has risen to an elevation leading to surface discharge along faults, fractures, or mine workings. Spring and seep surveys have been conducted as part of remedial investigations to establish baseline conditions for the California Gulch Superfund Site.

Observations of the emergence of new seeps or springs will occur during the course of other routine monitoring activities related to the Yak Tunnel. The flow measurements, field parameters, and water quality parameters of any new springs/seeps observed will be used to assess whether the new spring/seep represents an adverse water condition. The elevation, flow measurements, field parameters, and water quality parameters of the new springs/seeps may be used to assess the source of the new spring/seep.

The need to conduct systematic reconnaissance surveys of springs and seeps will be evaluated if a substantial water level rise is observed in piezometer BBW-8 (unrelated to bulkhead operation) or if any new seeps or springs are observed during routine monitoring activities discussed above.

As in the past, reconnaissance surveys of seeps and springs will focus on the south side of Iron Hill where surface discharge of Yak Tunnel water is most likely to occur. Upon the first observation of a new spring or seep, flow measurements, elevation, field parameters and water quality parameters will be collected at the new and any existing springs or seeps in the vicinity of the new spring or seep.

3.0 SAMPLING, MONITORING AND ANALYTICAL PROCEDURES AND METHODS

This Chapter addresses requirements for sampling, monitoring, sample analysis, quality assurance, data validation, recordkeeping and reporting. Yak Tunnel flow rates, groundwater and surface water samples will be collected and analyzed in accordance with the following procedures to ensure the information needed to support the CP decision process is obtained. Sampling and monitoring procedures are described in detail in Standard Operating Procedures (SOPs) included in Appendix A of the Work Plan (MFG, 2008b). SOPs required for the RMP include:

SOP Number	Title
1	Decontamination
2	Well Water Level Measurement
3	Field Instrument Calibration and Operation
4	Ground Water Monitoring Well Sampling
5	Surface Water Flow Measurement
6	Surface Water Sample Collection
7	Sample Handling, Documentation, and Analysis
8	Water Treatment Plant Sampling
10	Field QA/QC Samples
11	Water Level Measurement Using Pressure Transducers

Specific procedures to perform routine monitoring are provided below.

3.1 Sampling and Monitoring Methods

3.1.1 Sample Collection

Groundwater samples from the BBW wells and piezometers and direct sampling from mine shafts will be collected according to the methods described in SOP No. 4-Ground Water Monitoring Well Sampling. Spring and seep samples will be collected according to the methods described in SOP No. 6-Surface Water Sample Collection. Yak Tunnel blockage water samples collected at the BIL sampling port at the Yak Tunnel WTP will be collected according to the methods described in SOP No. 8-Water Treatment Plant Sampling.

Non-disposable sampling equipment will be decontaminated prior to collection of every sample according to the methods described in SOP No. 1-Decontamination. Sample collection documentation, sample containment, preservation, identification, labeling and shipping will be performed according to the procedures described in SOP No. 7- Sample Handling, Documentation, and Analysis.

3.1.2 Groundwater Level Measurement

Manual groundwater level measurements from the BBW wells/piezometers and mine shafts will be performed according to the methods described in SOP No. 2-Well Water Level Measurement. Groundwater level measurements and data collection using pressure transducers will be performed according to the methods described in SOP No. 11-Water Level Measurement Using Pressure Transducers. Water level monitoring equipment will be decontaminated prior to use according to the methods described in SOP No. 1 - Decontamination.

3.2 Equipment Calibration, Maintenance, and Decontamination

Equipment used for the collection of samples and measurement of field parameters will be calibrated, maintained and operated properly to ensure that representative samples and measurements are obtained. Field parameter instruments will be calibrated according to the methods described in SOP No. 3- Field Instrument Calibration and Operation. Water level measurement equipment will be calibrated according to the methods described in SOP No. 2-Well Water Level Measurement and SOP No. 11-Water Level Measurement Using Pressure Transducers. Non-disposable equipment used for the collection of samples, measurement of field parameters, and measurement of water levels will be decontaminated prior to use and between sampling locations. Decontamination will be performed in accordance with SOP No. 1-Decontamination.

3.3 Analytical Methods

Samples will be analyzed according to the methods listed in Table 3. The specified methods provide data of appropriate quality for performing routine monitoring of the Yak Tunnel Operable Unit. Table 3 also includes the method detection limits (MDLs). Sample container, preservation, and holding times are provided in SOP No. 7-Sample Handling, Documentation, and Analysis.

One or more laboratories will be used to perform analyses of samples collected. The laboratory will be required to process all samples submitted according to the specific protocols for sample custody, holding times, analysis, reporting and associated laboratory quality assurance. Designated laboratory personnel will be required to ensure that QA/QC procedures are achieved. The laboratory utilized will be required to allow access by employees of the EPA and the State of Colorado. The laboratories contracted for constituent analysis must be accredited by the Colorado Certification Program.

3.4 Quality Assurance/Quality Control (QA/QC)

The Work Plan (MFG, 2008b) serves as the QAPP for the RMP, with the modifications presented below. These QA/QC protocols serve to assure that the data collected pursuant to this plan meet specified standards of precision, accuracy, representativeness, comparability, and completeness.

3.4.1 Quality Assurance/Quality Control Samples

Field quality control (QC) samples to be collected include field duplicates, equipment rinsates, and field blanks. Quality control samples will be collected in accordance with SOP No. 10-Field QA/QC Samples. Field duplicates, equipment rinsates, and field blanks will be collected during groundwater and spring/seep sampling. These field QC samples will be collected at a rate of one per batch of 20 samples or one per day, whichever is more frequent. For purposes of groundwater quality sampling, one batch of QC samples will be obtained from the monitoring network during each sampling event.

Laboratory quality assurance checks will include the use of blank, spiked, split, and duplicate samples, calibration checks, and internal standards. The laboratory will analyze one matrix spike and one duplicate sample per sample delivery group. The sample delivery group is defined as a group of up to 20 samples received within a 14-day period. At a minimum, laboratories selected to perform the sample analyses will be required to report the QC results that are necessary to perform the data quality evaluation (Section 3.5). In addition, copies of the chain-of-custodies, sample log-in forms, and a report narrative will be included with each data package. The data will be reported in both electronic and hard copies unless otherwise agreed.

3.5 Data Quality Assessment and Validation

3.5.1 Data Quality Assessment

The quality of data obtained for RMP purposes will initially be assessed by comparing the data against historic data and looking for significant deviations. The data will be reviewed in an attempt to identify any transcriptional or computational errors. Presence of anomalous data will initiate a review of sampling, handling, analytical, and data management procedures, and in the event that data of questionable quality are identified, water levels and field parameters may be re-measured and water samples will either be reanalyzed or resampling may be recommended. The QC and other data will be evaluated to reach decisions regarding the usability of the original data. Data errors, corrections, or deletions will be discussed in the Annual Monitoring Report.

3.5.2 Field QA/QC Samples Evaluation

Field QC samples will be evaluated to determine QC of sampling procedures. Field QC will be evaluated as follows:

- Comparison of Dissolved and Total Concentrations.

  Samples in which both total and dissolved analyses were requested are reviewed to determine if dissolved concentrations exceed total concentrations. Typically, dissolved metal concentrations are less than total metal concentrations; however, dissolved metals concentrations may slightly exceed the total metals concentrations. If dissolved concentrations exceed total concentrations, the laboratory may be requested to re-analyze the digestates and dissolved samples. The relative percent difference (RPD) is calculated if dissolved concentrations exceed total concentrations.

$$RPD = ((T-D) \times 100)/((T+D)/2)$$

where: T = total concentration (mg/L
D = dissolved concentration (mg/L).

If the RPD is greater than 20 percent, both results are qualified as estimated.

- Field Duplicate Analysis

  Field duplicates are collected and analyzed as an indication of overall precision. These analyses measure both field and lab precision; therefore, the results may have more variability than lab duplicates which measure only lab performance. A comparison of primary and duplicate samples is conducted to determine the variance or relative percent difference (RPD) between the concentrations of each analyte. A target control limit of ± 20 percent for the RPD will be used for primary and duplicate samples greater than or equal to five times the detection level. A target control limit of ± the detection level will be used when either or both the primary and duplicate samples are less than five times the detection level.

If the target control limit is exceeded, it will be noted in narrative comments accompanying the data validation report. As a possible indication of the source of the variance, the RPDs of associated laboratory duplicate analysis will be checked. If it appears that the source of the variance was not due to the laboratory analysis, then field procedures will be reviewed. If field procedures were a potential source of variance it will be noted in the narrative report.

- Evaluation of Field and Equipment Blank Analyses

  If any analyte is detected in the equipment rinsate or field blank, field sample results within a factor of five times the concentration found in an associated blank are qualified as U/non-detect.

3.5.3 Laboratory Data

Laboratory calculations and data review will be performed by the laboratory in accordance with the procedures described by the analytical method. The laboratory will review the results of the laboratory QC analyses, instrument calibration and maintenance records, calculations, and the record of sample custody (including holding times) within the laboratory.

Following receipt of the data from the laboratory, the data quality will be evaluated. The purpose of data validation is to assess the data quality, using information such as sample holding times, and laboratory and field quality assurance. Laboratory data will be reviewed and validated in accordance with the Work Plan (MFG, 2008b).

3.6 Data Handling Procedures

For the evaluation of data, the following data handling procedures will be used:

- When parameter concentrations are reported by the analytical laboratory as non-detect, the detection limit value will be used in graphical presentations and, where necessary, to perform statistical analyses.
- For data which are detected by the laboratory but "U" flagged by the data validator (indicating that the results should be considered non-detect), those results will be considered non-detect for all non-statistical purposes. However, a judgment will be made as to whether the data will be usable for statistical purposes at the concentration detected by the laboratory. If the U-flagged result is consistent with previously observed results and the data user feels that the result is representative of the sample

collected, then the concentration reported by the laboratory may be used for statistical purposes only. The use of the reported concentration of a U-flagged data point should be noted on all tables, graphs, or other products to which it applies.

- Plots of logarithmic data, such as pH and log-transformed data, may be shown on semi-log plots to facilitate linear trend analysis.
- Parameter values for duplicate samples will not be averaged for statistical analyses; the original value will be used, unless rejected by the data validator.

3.7 Data Management

The RMP database will consist of data collected under the routine monitoring program from the beginning of monitoring, which is defined as October 1989, in the case of the Yak Tunnel, throughout the routine monitoring period. The RMP database will consist of two databases: one which includes data associated with the Yak Tunnel flow rates and one that includes relevant data obtained from other site activities, including groundwater, spring/seep and supplemental monitoring. The Yak Tunnel flow rate database will be maintained at the treatment plant in accordance with the Work Plan. The database for the groundwater, spring/seep and supplemental monitoring will be maintained by the project consultant. Data included in the databases will meet the following two criteria:

- An evaluation indicates that the data represent natural fluctuations in conditions within the Yak Tunnel Hydrologic System.
- An evaluation of the QC data indicates that no significant QC deviations occurred. Data which is rejected by the data validator will not be included in the database, however an indication that the sample was collected, analyzed and rejected will be made in the database.

4.0 DATA EVALUATION

During routine monitoring, field measurements and analytical data will be obtained from the monitoring of the Yak Tunnel Hydrologic System as described in Sections 2 and 3 above. Following the data quality review (Section 3), the monitored data will be evaluated as soon as practicable to provide the information necessary to support CP decision-making. The parameters listed on Table 1 were selected to support the decision-making process described in the CP. Data and information collected under this RMP will be evaluated using standard data reduction and analysis methods.

4.1 Yak Tunnel Bulkhead

Monitoring data that will be collected relative to the Yak Tunnel include water level measurements at the bulkhead, flow rates, and field parameters and water quality parameters. In addition, visual inspections will be performed as part of operations and maintenance. Data obtained from monitoring of the Yak Tunnel Hydrologic System will be evaluated as follows:

- Water levels measured behind the bulkhead will be graphed versus time. Precipitation and snow melt data, to the extent such data is available form other sources, will also be included on the graphs to aid in the interpretation of water level changes.
- Total monthly flow rate measurements at the GIL will be graphed versus time. Precipitation and snow melt data, to the extent such data is available form other sources, will also be included on the graphs to aid in the interpretation of flow rates.
- Field parameters (pH and specific conductance) will be graphed versus time and water levels behind the bulkhead.
- Other water quality parameters will be reviewed for data which appear anomalous. If anomalous data are present, the data for that parameter will be graphed versus time or other parameters (such as pH or water levels) in an attempt to discover a correlation or explanation for the anomalous data. Ion balances may be calculated.

Correlations with previous seasonal or annual trends will be evaluated for the water levels, flow rates, and field parameters.

4.2 Groundwater

Groundwater monitoring data will include water level measurements and field and water quality parameters from the BBW wells and piezometers, the Black Cloud, Irene, and Helena mine shafts, and the water behind the Yak Tunnel blockage. Data obtained from groundwater monitoring will be evaluated as follows:

- Water levels at each location will be graphed versus time (hydrographs). The hydrographs will be compared to the hydrograph produced for the Yak Tunnel bulkhead. Precipitation and snow melt data, to the extent such data is available form other sources, will also be included on the graphs to aid in the interpretation of water level changes.
- Field parameters (pH and specific conductance) will be graphed versus time and the water level for each location.
- Other water quality parameters will be reviewed for data which appear anomalous. If anomalous data are present, the data for that parameter will be graphed versus time or other parameters (such as pH or water levels) in an attempt to discover a correlation or explanation for the anomalous data. Ion balances may be calculated.

Correlations with previous seasonal or annual trends will be evaluated for the water levels and field parameters. Stiff diagrams or piper diagrams may be plotted for further evaluation of the groundwater chemistry.

4.3 Springs/Seeps

Information collected during spring/seep reconnaissance surveys will include visual observations of the spring/seep occurrence, spring/seep flow measurements, elevations, and field and water quality parameter measurements. This information will be documented in photographs, field notes, GIS or using other reliable methods. The spring/seep reconnaissance survey data will be evaluated as follows:

- New springs/seeps will be plotted on a map for comparison to other springs/seeps, geologic features, and man-made features such as mine shafts, tunnels, drifts, excavations, waste rock piles and tailing piles.
- The elevation of the new seep/spring will be compared to the groundwater elevations in the Yak Tunnel and surrounding monitoring wells and piezometers.
- Spring/seep duration and flow measurements will be compared to precipitation and snow-melt trends.
- Spring/seep parameters will be compared to the field parameters for the Yak Tunnel and surrounding monitoring locations to evaluate correlations.

5.0 SYSTEMATIC REVIEW AND REVISION OF MONITORING PLAN

5.1 Need For Periodic Review And Revision of Monitoring Plan

Systematic review and revision of the RMP will take place under Decision 6 and Task F of the CP. As the routine monitoring program progresses, it is expected that modifications of the RMP will be required.

In general, routine monitoring requirements will be modified whenever a better understanding of the Yak Tunnel Hydrologic System suggests that monitoring elements should be updated, or when the specific objectives of the monitoring program change. These objectives may change if, as a result of Tasks A and B in the CP, the decision is made that additional investigations or enhanced monitoring are needed. In such a case, the objectives and requirements of the additional investigations or enhanced monitoring will be incorporated into the RMP as required by EPA after consultation with the State. Additional monitoring or data analysis may also be required to provide sufficient evidence to support Decisions 3, 4A and 4B of the CP; that is, to determine whether a gradient reversal has occurred or adverse water conditions exist, and whether response action is required. Finally, additional monitoring requirements may be added to the RMP as a component of one or more response actions selected under Task E of the CP.

The types of changes that may be made to the RMP as a result of systematic review and revision of the monitoring program may include:

- Addition or deletion of monitoring points
- Change in the frequency or location(s) of monitoring
- Addition or deletion of flow, field and water quality parameters
- Modification of the methods used to perform field measurements or laboratory procedures
- Changes in the methods of analysis applied during data evaluation

5.2 Procedure for Modification of Plan

The basic procedure for modification of the RMP consists of the periodic review of the contents of the RMP, confirmation of conformance with the objectives of the program and the effectiveness of the program in supporting decision-making pursuant to the CP. If it is determined that the RMP is not meeting these objectives, recommended improvements will be presented to EPA and the State for approval. The review will include all aspects of routine monitoring as well as specific evaluations and analyses. At a minimum, the RMP will be reviewed annually at the time the Annual Monitoring Report is being prepared.

As more information is gained about the Yak Tunnel Hydrologic System, and as data collection procedures, laboratory analysis methods, methods used for data evaluation and technology changes, and as the usefulness of the collected data is reevaluated, modifications may be appropriate to improve the efficiency and cost-effectiveness of routine monitoring. In such events, this RMP may likewise be modified with the approval of EPA after consultation with the State.

At the conclusion of the RMP review under Decision 6 of the CP, recommendations may be made for modification of the RMP. Decision 6 of the CP considers whether or not the RMP requires revision. These recommendations will be presented and justified in the Annual Monitoring Report. In addition, EPA, after consulting with the State, may require modifications to the RMP. The revised RMP will be implemented immediately after receipt of EPA approval of the revised document. If the revision requires a phased implementation of the recommended changes, the schedule for implementation will be provided in the revised RMP.

6.0 ROUTINE REPORTING

An Annual Monitoring Report will be prepared as part of the routine monitoring program, as provided in Section 5.8.3.2 of the Work Plan. This document constitutes the reporting component of Task A of the CP, and will summarize the results of the routine monitoring program and evaluations made during consideration of Decisions 3 and 6 of the CP. The content of a typical report is described below.

The Annual Monitoring Report will document and summarize monitoring program and investigation activities that have taken place during the entire year. The report will provide a summary of routine or enhanced monitoring data collected during the year, along with the results of any investigations initiated pursuant to Decision 6. It will also include updated databases in a form approved by EPA and the State. A duplicate copy of the databases will be maintained in accordance with the data management procedures described in the Work Plan. A current description of hydrologic conditions within the Yak Tunnel Hydrologic System will be provided, and any unusual events observed throughout the year will be noted.

The report will include the following information:

- Summary of routine and enhanced monitoring activities
- Summary and evaluation of Yak Tunnel bulkhead data including water levels, flows, and water quality data
- Summary and evaluation of groundwater levels and quality
- Summary and evaluation of Yak Tunnel blockage pumping data
- Conclusions and recommendations

A data evaluation summary will be presented in the Annual Monitoring Report. This will contain the results of data evaluation procedures such as statistical analyses; interpretations of data correlations; and evaluations of data completeness, representativeness, comparability, precision, and accuracy.

Finally, the Annual Monitoring Report will review the current status of the RMP, summarize revisions that have been considered or adopted during the year, and if necessary, recommend changes or improvements to routine monitoring that might be justified for the upcoming year. Topics that will be discussed in this part of the report include existing or proposed modifications to the monitoring program, if any, and objectives and results of any enhanced monitoring or additional investigations that were undertaken during the previous year.

The Annual Monitoring Report will be due 90 days after the end of the calendar year.

Monthly reports will be prepared as part of the routine monitoring program, as provided in Section of 5.8.3.1 of the Work Plan. As discussed above, downloading of data loggers and manual water level measurements will occur tri-annually at all wells, piezometers, and mine shafts during the spring, summer, and fall seasons. These data will be provided to EPA and the State with the first Yak Tunnel monthly progress report following each tri-annual data download. Also, the Yak Tunnel monthly progress reports providing the tri-annual data will state whether there was any determination under the CP that enhanced monitoring or additional investigations are required, or that an adverse water condition or hydraulic gradient reversal has occurred. After receipt of the monthly reports providing the tri-annual data, the EPA and the State may contact the operator to discuss any trends or anomalies in the reported data.

7.0 REFERENCES

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TABLES

Table 1 Sampling Locations, Parameters and Monitoring Frequencies, Yak Tunnel – Operable Unit 1

Location	Parameter [1], [2]	Method	Data Collection Frequency
Yak Tunnel Bulkhead	Water Level	Transducer	Recorded Manually Daily
	Flow Rate (at the Gravity Influent Line)	Flow Meter	Daily (during water treatment plant operation)
	Field Parameters (GIL sampling port)		Daily (during water treatment plant operation)
Groundwater Elevation and Blockage Monitoring Points	Water level in BBW-1 and BBW-2	Manual	Spring, Summer, Fall
	Water level in BBW-3, BBW-4, BBW-7, BBW-8, and Helena Shaft	Manual	Spring, Summer, Fall
		Transducer[4]	Weekly
	Water level in BBW-5, BBW-10, and Irene Shaft	Manual	Spring, Summer, Fall
		Transducer[4]	Daily
	Water level in Black Cloud Shaft	Manual	Spring, Summer, Fall
		Transducer[4]	Daily
	Flow rate at BIL	Flow Meter	Daily
Groundwater Quality Monitoring Points	Field and Water Quality Parameters in BBW-1, BBW-2, BBW-3, and BBW-4		Every 5 years
	Field and Water Quality Parameters BBW-5, BBW-10, and Yak Tunnel blockage [3]		Semi-annually
Springs/Seeps	Occurrence/Elevation		As required (on first observation)
	Stream Flow		As required (on first observation)
	Field and Water Quality Parameters		As required (on first observation)

Notes: (1) Field parameters include pH, specific conductance, temperature, and turbidity.
(2) Water quality parameters presented in Table 3.
(3) Water quality sample from Yak Tunnel blockage taken from Black Cloud Shaft, Irene Shaft, or BIL sampling port.
(4) Transducer data downloaded tri-annually in Spring, Summer, and Fall during manual measurement event.

Table 2 Summary of Monitoring Well/Piezometer Construction Details-Yak Tunnel OU1

Location Identification	Date of Installation	Elevation (ft amsl)		Casing Diameter (in.)	Screen Type(2)	Well Screen Interval					Total Depth of Well (ft BTOC)	Total Depth of Boring (ft BGS)	Elevation of Bottom of Boring (ft amsl)
		Top of PVC Casing	Approx. Ground Surface			Length (ft)	Approx. Depth bottom of screen (ft BTOC)	Approx. Elevation bottom of screen (ft amsl)	Hydrogeologic Unit- Fault Monitored	Est. Tunnel Elevation (ft amsl)			
BBW-1	9/13/91	11,220.43	11,220.2	2	S.S	40	901.0	10319.4	Bedrock-Pilot	10,350	901	914	10,306.20
BBW-2	10/19/91	10,796.26	10,794.5	2	S.S	38	460.2	10336.1	Bedrock-Pilot	10,347	462	475	10,319.50
BBW-3	10/5/91	11,236.11	11,235.2	2	S.S	39.9	779.5	10456.6	Bedrock-Weston	10,369	781	797	10,438.20
BBW-4	9/26/91	11,555.91	11,543.9	2	S.S	40.2	1199.5	10345.4	Bedrock-Weston	10,356	1200	1227	10,316.90
BBW-5	10/15/91	11,190.53	11,189.2	2	S.S	40	860.7	10329.8	Bedrock-Silent Friend (YakT.)	10,386	861	900	10,289.20
BBW-7	9/7/91	10,445.06	10,443.8	2	S.S	40	292.0	10153.1	Bedrock-Iron/Mikado/ Emmet	10,333	292	291	10,152.80
BBW-8	10/29/91	10,920.30	10,916.0	2	S.S	40	636	10284.3	Bedrock-Adalaide (Yak T.)	10,344	638	665	10,251.00
BBW-10	11/24/91	11,059.70	11,056.0	2	S.S	40	753	10306.7	Bedrock-Silent Friend (?)	10,382	750	825	10,231.00

S.S = stainless steel
amsl =above mean sea level
BTOC = below top of casing
BGS = below ground surface

Table 3 Analytical Methods and Detection Limits for Groundwater and Seep Samples –Operable Unit 1

Parameter	Analytical Method	Reference	Detection Limit	Units
<u>Field</u>				
Flow rate	Parshall flume reading	SOP NO. 5	0.1	cfs
Water level	Manual/data logger reading	SOP NO. 2	0.01	foot
pH	Meter	EPA 150.1/SOP NOS. 4, 6	0.1	std pH unit
Specific conductance	Meter	EPA 120.1/SOP NOS. 4, 6	1	µS
Temperature	Thermometric	EPA 170.1/SOP NOS. 4, 6	0.1	°C
Turbidity	Nephelometric	EPA 180.1	N/A	NTU
<u>Laboratory</u>				
General Chemical Constituents:				
Total alkalinity	Titrimetric	EPA 310.1	2	mg/L
pH	Meter	EPA 150.1	0.1	std. pH unit
Specific conductance	Meter	EPA 120.1	1	µS
Total dissolved solids	Gravimetric	EPA 160.1	2	mg/L
<u>Major Inorganic Constituents</u>				
Calcium	ICP	EPA 200.7	1	mg/L
Chloride	IC	EPA 300.0	1	mg/L
Magnesium	ICP	EPA 200.7	1	mg/L
Potassium	ICP	EPA 200.7	1	mg/L
Sodium	ICP	EPA 200.7	1	mg/L
Silica	ICP	EPA 200.7	1	mg/L
Sulfate	Gravimetric	EPA 375.3	4	mg/L
<u>Dissolved Metals</u>				
Aluminum	ICP or ICP/MS	EPA 200.7/200.8	50	µg/L
Arsenic	ICP or ICP/MS	EPA 200.7/200.8	1	µg/L
Cadmium	ICP or ICP/MS	EPA 200.7/200.8	5	µg/L
Copper	ICP or ICP/MS	EPA 200.7/200.8	10	µg/L
Iron	ICP	EPA 200.7	20	µg/L
Lead	ICP or ICP/MS	EPA 200.7/200.8	1	µg/L
Manganese	ICP or ICP/MS	EPA 200.7/200.8	10	µg/L
Nickel	ICP or ICP/MS	EPA 200.7/200.8	20	µg/L
Zinc	ICP or ICP/MS	EPA 200.7/200.8	10	µg/L

IC = ion chromatography
ICP = inductively coupled plasma - atomic emission spectroscopy
ICP/MS = inductively coupled plasma/mass spectrometry
EPA 6010/6020 may be used in place of EPA 200.7/200.8

FIGURES

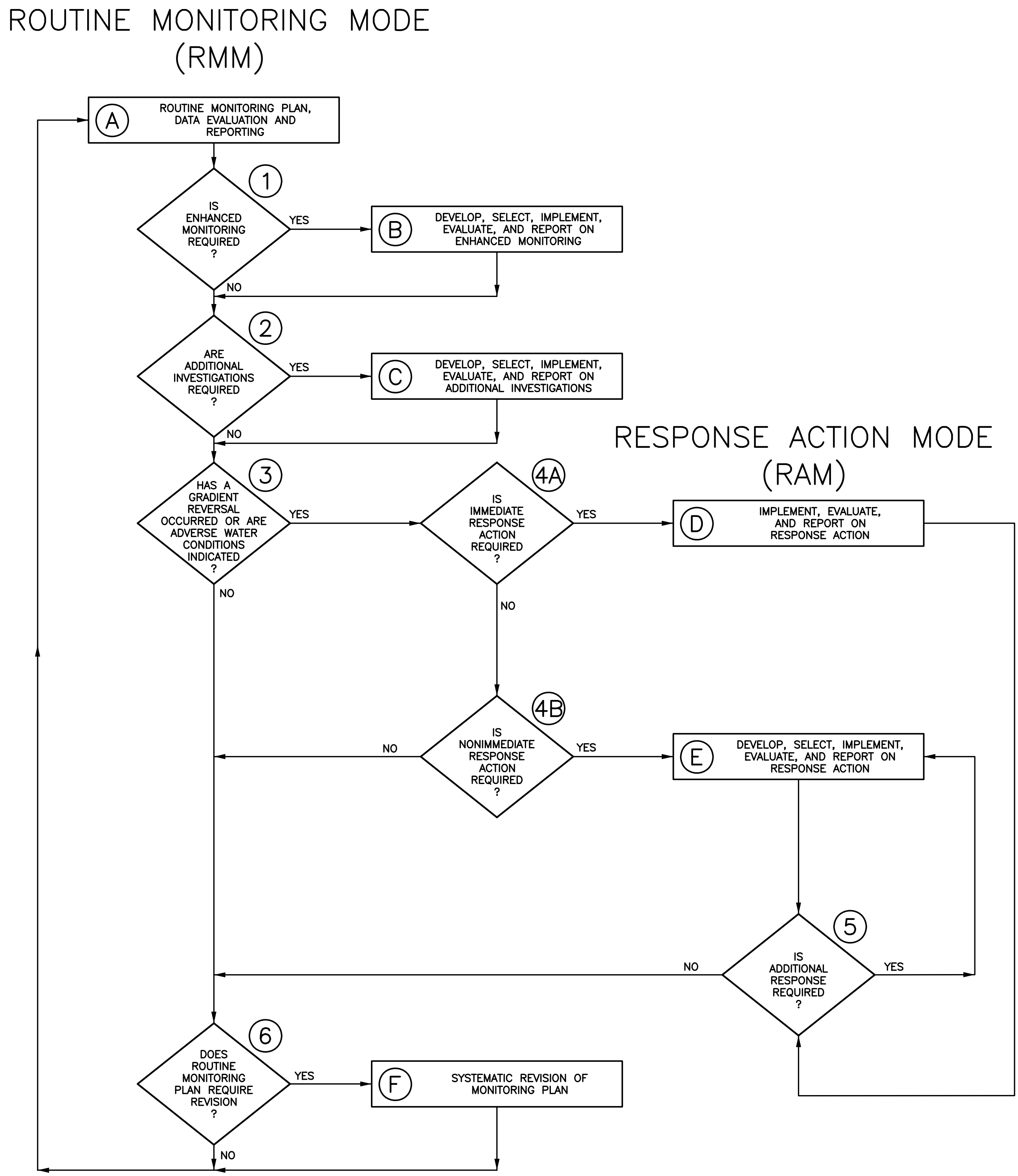

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FIGURE 1
CONTINGENCY PLAN FLOW CHART

Date:	MAY 2008
Project:	180885/37
File:	Figure-01.dwg

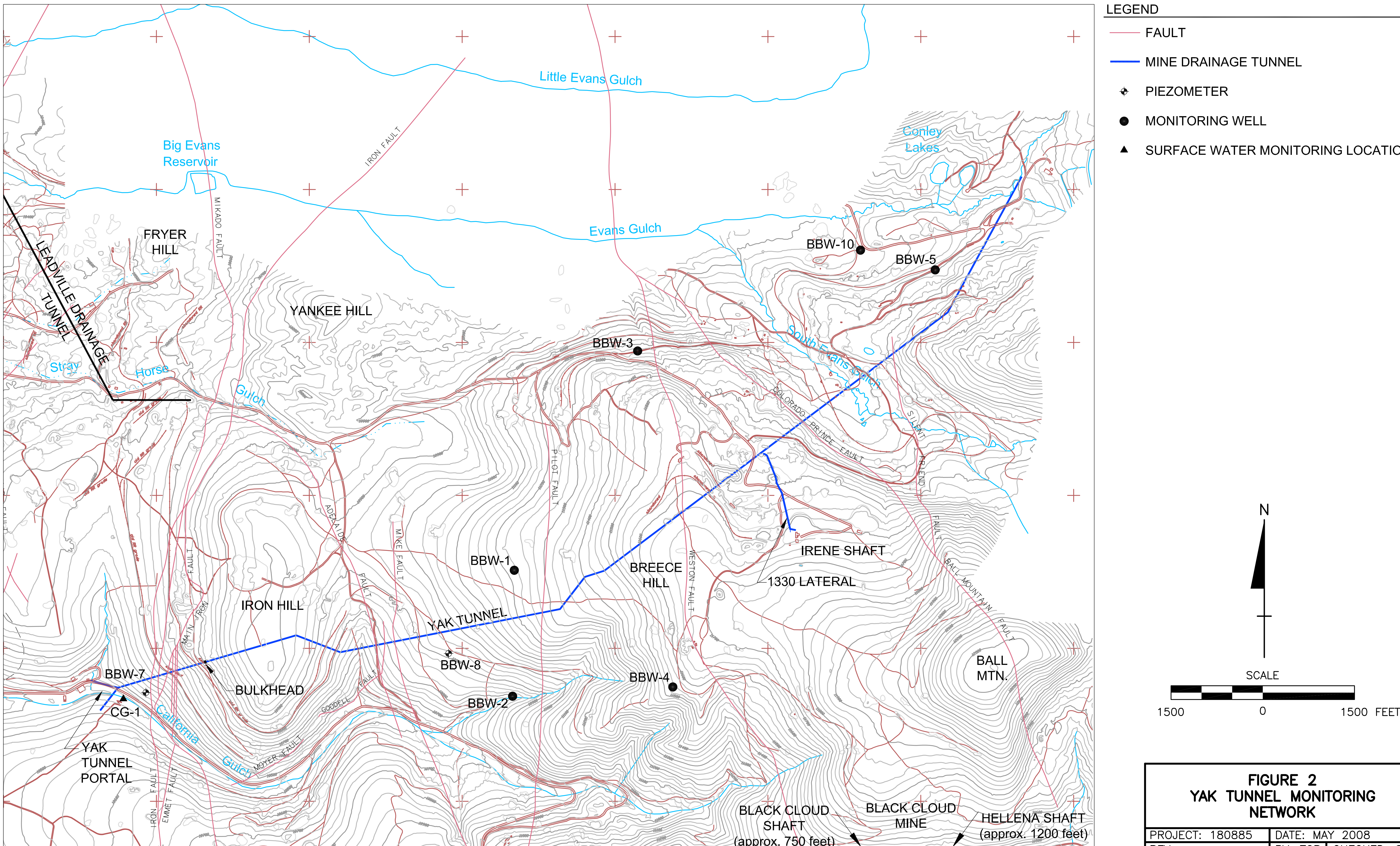

FIGURE 2
YAK TUNNEL MONITORING NETWORK

PROJECT: 180885	DATE: MAY 2008	
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APPENDIX E

TO OU1 WORK PLAN

CONTINGENCY PLAN

APPENDIX E
TO OU1 WORK PLAN

2008 CONTINGENCY PLAN
YAK TUNNEL OPERABLE UNIT 1
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO
MAY 2008

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Appendix A Glossary

1.0 INTRODUCTION

This 2008 Contingency Plan (CP), the 2008 Routine Monitoring Plan (RMP) (MFG, 2008a), and the Work Plan for OU1 (Work Plan) (MFG, 2008b) govern implementation of the selected remedy for the Yak Tunnel Operable Unit (OUl), California Gulch Superfund Site, Leadville, Colorado, pursuant to the Consent Decree by and among the United States, State of Colorado, Newmont USA Limited and Resurrection Mining Company, to which the OU1 Work Plan and this CP are appended. The CP describes the decision-making process for identifying gradient reversals and adverse water conditions related to the Yak Tunnel Hydrologic System, and for designing and implementing appropriate actions to respond to such conditions. Conditions constituting gradient reversal and adverse water conditions are enumerated in Table 1 of this Plan.

The RMP describes the objectives, monitoring points, data criteria for implementation of the CP decision- making process, sampling and laboratory methods, quality assurance procedures, data evaluation methods, and reporting requirements that will be implemented during the routine monitoring mode of operation of the CP.

The CP incorporates revisions and updates to the prior contingency plan to reflect current conditions associated with the Yak Tunnel Hydrologic System, including the cessation of mining activities at the Black Cloud Mine in 1999 and the formation of a blockage in the Yak Tunnel in approximately 2002.

1.1 Summary of Current Conditions

Beginning in May 2002, increasing water levels were observed at piezometer BBW-5 and well BBW-10. The rise in groundwater elevations occurred coincident with the recovery of groundwater levels in the Black Cloud Mine workings above the level of the 1330 Lateral, and indicated that a blockage existed in the upper region of the Yak Tunnel downgradient of the 1330 Lateral.

Pursuant to the former Contingency Plan (MFG, 1999), it was determined that enhanced monitoring was required. An enhanced monitoring program was submitted to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and

Environment (CDPHE) in a letter dated December 19, 2002 (Asarco, 2002). As prescribed by the enhanced monitoring program (Asarco, 2002), water levels in BBW-3, BBW-5, BBW-10, and the Black Cloud/Irene shafts have been measured at an increased frequency since December 2002 to assess groundwater conditions in the upper portion of the Yak Tunnel and the Black Cloud Mine. In 2004, the Additional Investigation Work Plan (MFG, 2004) was implemented to provide information to supplement the routine and enhanced monitoring programs and to develop a better understanding of the current conditions within the Yak Tunnel Hydrologic System and the potential implications or consequences if water levels were allowed to continue to rise.

The Additional Investigation Work Plan described pumping of groundwater from behind the blockage and conveyance of this water to the Yak Tunnel Water Treatment Plant for treatment and discharge. Pumping of the Yak Tunnel blockage water from the Black Cloud Shaft began on March 21, 2006. Historic high groundwater elevation within the Yak Tunnel mine pool of 10,684 feet above mean sea level (ft. amsl) was reached at the Black Cloud Shaft prior to the initiation of pumping on March 21, 2006. Pumping has continued since the March 21, 2006 start-up (with periodic shutdowns for maintenance), and water levels in the Yak Tunnel mine pool have dropped as a result. At the historic high groundwater elevation, the groundwater elevation data continued to indicate a hydraulic gradient towards the Yak Tunnel. Therefore, no reversal of the hydraulic gradient away from the Yak Tunnel or adverse groundwater quality conditions are expected away from the Yak Tunnel as long as pumping continues and the groundwater elevation remains below the historic high groundwater elevation. Continued pumping from the Black Cloud Shaft is anticipated to reduce and maintain water levels behind the blockage and is included in the Work Plan. This CP reflects current conditions within the Yak Tunnel Hydrologic System including such pumping. Should changing conditions warrant, additional response actions may be required pursuant to this CP, which may include pumping from other areas of the System in addition to, or instead of, the Black Cloud Shaft.

1.2 Contingency Plan Objectives

The development of a contingency plan that addresses any potential adverse hydrologic change occurring in the Yak Tunnel Hydrologic System is one of the elements of the selected remedy for OU1. The CP was prepared to satisfy that requirement and to meet the following objectives:

- Define the decision-making process by which the operational status of OU1 will be evaluated to determine whether hydraulic gradient reversal has occurred or adverse water conditions exist and whether those conditions warrant response action.
- Present the basis for the CP decision-making process, including the information needed to make each decision, the protocol that will be followed while each decision is being made, and the person(s) or decision-making body designated to make each decision.
- Describe the actions that will be taken to develop, select, implement, evaluate, and report on the outcome of the CP decisions and associated activities.
- Define the reporting, notification, and review requirements associated with the decisions and tasks identified in the CP.
- Define the degree of involvement and interactions among the parties charged with the implementation and operation of the CP.

In addition to the general objectives listed above, quality assurance and quality control (QA/QC) protocols serve to assure that the data collected as a part of the RMP meet specified standards of precision, accuracy, representativeness, comparability, and completeness. QA/QC protocols are presented in the Work Plan and RMP.

1.3 Contingency Plan Overview

The decision-making process that will be followed during evaluation of monitoring data and implementation of contingency measures, as necessary, is described below and shown in Figure 1. The CP decision-making process illustrates the relationship between the routine monitoring and response action components of the CP. Rectangular elements shown in the CP Flow Chart (Figure 1) represent contingency planning or activity tasks and diamond-shaped elements represent contingency planning decisions. The normal mode of operation of the CP, called the Routine Monitoring Mode of Operation (RMM), consists of all routine monitoring, data evaluation, and reporting activities associated with the execution of Tasks A, B, C and F and the evaluation of Decisions 1, 2, 3, 4A, 4B, and 6 of the CP. These activities are summarized in Section 2 of this document, and a detailed description of the associated monitoring activities is provided in the RMP. Activities associated with implementation of Tasks D and E and Decision 5 constitute the Response Action Mode of Operation (RAM) of the CP. The RAM is initiated when adverse hydrologic conditions have been demonstrated, and the need for response action is warranted.

Implementation of the routine monitoring program for the Yak Tunnel Hydrologic System occurs in Task A. Monitoring was implemented with the Draft Routine Monitoring Plan (Baker, 1993) and has provided an understanding of the range of fluctuations within the hydrologic system, allowing for the evaluation of existing conditions and overall system performance. Routine monitoring of various parameters provides information to continually update the monitoring database that documents the hydrologic conditions within the Yak Tunnel Hydrologic System, and to determine whether a significant change as compared to previously recorded data has occurred. A summary of the monitoring and data evaluation requirements for Task A is presented in Section 2.1.

During the RMM, modifications to the monitoring program have been and will continue to be implemented during execution of Task F, as required by EPA in consultation with the State. As part of this task, the monitoring program will be reevaluated on a routine basis and revised if necessary as specified in the RMP. Revisions not initially requested by the regulatory agencies will first be presented to EPA and the State for review and approval. The types of revisions that may be made to the RMP include initiation or curtailment of enhanced monitoring or implementation of additional investigations. Once approved, the revised RMP will remain in effect until additional modifications become necessary.

The major decision that affects routine monitoring is Decision 3. Consideration of Decision 3 involves a determination of whether a hydraulic gradient reversal away from the Yak Tunnel has occurred, or if an adverse water condition, is observed in the Yak Tunnel Hydrologic System. The term adverse water condition is defined in Table 1. If there is a gradient reversal or creation of adverse water condition (Answer to Decision 3 is YES), then Decision 4A will determine whether or not an immediate response action is required. If an immediate response action is found to be necessary (Answer to Decision 4A is YES), then the CP will enter the RAM. In this mode of operation, alternatives will be implemented, and evaluated during Task D. If consideration of Decision 4A results in a negative response (Answer to Decision 4A is NO), then Decision 4B will determine whether or not a non-immediate response action is required. If a non-immediate response action is found to be necessary (Answer to Decision 4B is YES), then the CP will enter the RAM. In this mode of operation, alternatives will be developed, selected, implemented, and evaluated during Task E. If consideration of either Decision 3 or Decision 4B results in a negative response (Answer to Decision 3 or 4B is NO), the process will continue with reevaluation of the monitoring plan, revision of the plan if necessary, and a return to routine monitoring.

After a given response action has been implemented, either immediate or non-immediate, the need for additional response will be evaluated in Decision 5. If further response is required, additional alternatives will be developed, selected, implemented, and evaluated in Task E. If no additional action is required (Answer to Decision 5 is NO), the results of the response action will be reported to EPA and the State, and the RMP will be reevaluated and revised as necessary in Decision 6 and Task F. Routine monitoring will then continue.

1.4 Contingency Plan Organization

The CP is organized around the Decisions and Tasks that form the basic elements of the two modes of operation. Section 1.0 describes the overall objectives, presents an overview of the CP -making process, and describes the organization of the CP. The Decisions and Tasks associated with the RMM are described in Section 2.0. The RAM, which includes Task D, Task E and Decision 5, and response action alternatives, is discussed in Section 3.0. References are presented in Section 4.0. Finally, a glossary of technical terms is provided in Appendix A.

2.0 ROUTINE MONITORING MODE OF OPERATION

2.1 Task A: Routine Monitoring Plan, Data Evaluation, and Reporting

2.1.1 Objectives of the Routine Monitoring Plan

The overall goal of the routine monitoring program is to obtain information about the Yak Tunnel Hydrologic System to support decision-making processes in the CP. This goal is embodied in the general objectives of the RMP, which are to:

- Provide information on current conditions of the Yak Tunnel Hydrologic System, and compare current conditions to all previously recorded conditions
- Provide information on changes that may occur in the Yak Tunnel Hydrologic System
- Provide information to support decisions regarding the need for enhanced monitoring activities, additional investigations, and the need for response actions, and
- Document the effectiveness of response actions that have been implemented.

2.1.2 Monitoring Elements

A detailed discussion of the elements that comprise the routine monitoring program is provided in the RMP. Section 2 of the RMP identifies monitoring parameters that are useful for ongoing characterization of changes or fluctuations in the Yak Tunnel Hydrologic System, and evaluation of conditions to identify potential undesirable changes within the Yak Tunnel Hydrologic System. Section 3 of the RMP describes the sampling and analytical methods of the sampling plan. Section 4 of the RMP presents procedures for qualitatively and quantitatively evaluating data to provide the information necessary to support the CP decision-making process.

Data collected during routine monitoring will be evaluated with previously reported data to determine what, if any, changes of conditions have occurred. Routine collection and evaluation of these data will provide an increased understanding of the hydrologic system, and allow the recognition of significant changed conditions, should they occur. The parameters and conditions which will be routinely monitored and evaluated include:

- Groundwater elevation
- Yak Tunnel Bulkhead water level

- Yak Tunnel Blockage water level
- Hydraulic gradient between the Yak Tunnel and outlying monitoring locations
- Yak Tunnel flow rates
- Piezometer and monitoring well field parameter and water quality parameters
- Mine shaft field parameter and water quality parameters
- Field parameters and water quality parameters at the Yak Tunnel bulkhead
- The occurrence, surface elevation, flow rate, and water quality of newly-observed seeps and springs.

The rationale for selection of monitored parameters and conditions, and monitoring location is provided in Section 2 of the RMP. Sampling locations that comprise the monitoring network are illustrated in Figure 2 of the RMP and the content of the monitoring program is summarized in Table 1 of the RMP.

2.1.3 Methods of Data Evaluation During Routine Monitoring

Data and information collected during routine monitoring will be evaluated using standard data reduction, graphical, and statistical analysis methods. These methods are described in Section 4 of the RMP. As with the rest of the RMP, methods used for data evaluation will be reviewed periodically and updated, deleted, or replaced as appropriate during the course of the monitoring program.

2.2 Decision-Making Process in RMM

2.2.1 Decision 1: Is Enhanced Monitoring Required?

As indicated in Figure 1, Decision 1 evaluates whether an enhanced monitoring effort is needed to confirm existing monitoring data or to provide supplemental information for the routine monitoring program. Enhanced monitoring could include increased frequency of monitoring or additional monitoring of parameters at existing sampling locations and monitoring points to provide specific information to address a suspected hydrologic condition. Enhanced monitoring could also include monitoring other existing sampling locations and monitoring points which are not part of the RMP. Possible elements of enhanced monitoring activities are developed in Task B, as described in Section 2.2.2.

In Decision 1, the need for enhanced monitoring is evaluated. If needed (Answer to Decision 1 is YES), the enhancements to the monitoring program will be developed, selected, implemented, evaluated, and reported under Task B. If unnecessary (Answer to Decision 1 is NO), then Decision 2 will be considered.

Although it is difficult to foresee all possible conditions where enhanced monitoring could be considered and selected, the following situations provide examples:

- A sudden change in head behind the Yak Tunnel Bulkhead could lead to an additional spring and seep survey in the vicinity of Iron Hill, or other additional monitoring activities.
- A sudden, unanticipated reduction in the Yak Tunnel flow rate or increase in head behind the bulkhead could lead to changes in the frequency of monitoring water levels behind the bulkhead, flows from the bulkhead, and measurements of water levels in one or more of the piezometers within the monitoring network. This situation could also initiate additional seep/spring surveys, sampling and analysis of Yak Tunnel water quality, and the performance of bulkhead O&M activities.
- A sudden, unexplained change in water quality from the Yak Tunnel bulkhead could warrant sampling of piezometers and/or wells.
- An anomalously rapid rise/fall of groundwater elevations in the Yak Tunnel Hydrologic System could prompt more frequent monitoring of water levels in the affected monitoring locations, as necessary.
- A significant, unanticipated water level rise in piezometer BBW-8 could lead to an additional seep and spring survey in the vicinity of Iron Hill.
- A significant, unanticipated water level rise in one or more wells/piezometers other than BBW-8 could lead to a seep/spring survey in areas adjacent to the affected piezometers or other locations, as appropriate, that may be connected by mine workings or other hydraulic connections.
- If a newly-occurring seep or spring were discovered during a seep/spring reconnaissance survey, or at any other time during the dry season, seep water quality would be evaluated.

Decision 1 will be made each time the routine monitoring results are evaluated. If the outcome of this decision suggests that enhanced monitoring is needed, this conclusion will be communicated in writing to EPA and the State within ten working days after the decision has been made.

2.2.2 Task B: Develop, Select, Implement, Evaluate and Report on Enhanced Monitoring

If consideration of Decision 1 indicates that enhanced monitoring is necessary, an enhanced monitoring program will be developed under Task B of the contingency planning process and provided to EPA and the State. The program will be designed to meet the specific needs of the situation depending on the type of conditions encountered. The enhancements will be implemented as soon as practicable after the EPA and the State have approved of the proposed enhanced monitoring program. Enhanced monitoring results will be evaluated and reported in accordance with the requirements established and set forth in the enhanced program. Each enhanced monitoring program will contain the following elements:

- Summary of the conditions that led to enhanced monitoring
- The objectives of the enhanced monitoring program
- A description of the enhancements that will be made to monitoring
- The data analysis and evaluation procedures that are anticipated to be performed on the resulting data
- The duration of the program
- Reporting requirements

When enhanced monitoring activities have been completed, the monitoring program will return to routine monitoring. If continuation of enhanced monitoring is determined necessary, the changes will be incorporated into the routine monitoring program under Task F as described in Section 5 of the RMP.

2.2.3 Decision 2: Are Additional Investigations Required?

Decision 2 evaluates the need to carry out additional investigations that may be needed to clarify or supplement data obtained from routine or enhanced monitoring. If the answer to Decision 2 is YES, an additional investigation will be developed, selected, implemented, and evaluated under Task C. If a NO decision is reached, Decision 3 will be considered.

Additional investigations may become necessary whenever information is needed to clarify Decisions 3, 4A, 4B, and 5, and such information cannot be obtained from the routine monitoring program network, enhanced monitoring, or from other existing monitoring locations.

In general, the objectives of an additional investigation will be more specific than those of an enhanced monitoring program, and may range from the installation of one or more piezometers or wells to the application of a new data evaluation technique. Circumstances that might lead to the initiation of an additional investigation include the following:

- The occurrence of a new seep/spring of adverse water quality that is discharging to a stream or surface water body
- The occurrence of a persistent, unexplained rise in groundwater elevations over a large area that is associated with the Yak Tunnel Hydrologic System
- A reversal of hydraulic gradient away from the Yak Tunnel, accompanied by a change in water quality in one of the outer monitoring wells
- The need to collect information to support the design or evaluation of a response action considered or selected in Tasks D or E

Decision 2 will be made each time routine monitoring results are evaluated. The decision to conduct an additional investigation will depend on the specific conditions that exist at the time the decision is considered. If the decision is made to conduct an additional investigation, EPA and the State will be notified of the decision in writing within ten working days and further planning/scoping of the investigation will begin.

2.2.4 Task C: Develop, Select, Implement, Evaluate, and Report on Additional Investigations

If the result of Decision 2 is to conduct an additional investigation, a Draft Additional Investigation Work Plan will be developed to respond to the specific conditions and questions that led to the decision. The Draft Additional Investigation Work Plan will contain the following elements:

- A summary of the conditions that led to the investigation
- The specific objectives of the investigation
- Details of the work to be conducted including a description of the location of any new wells/piezometers or other monitoring points that will be installed, sampling activities and field and laboratory analyses that will be performed, and other data collection activities
- Methods anticipated for data analysis and evaluation

- A summary of applicable waste management, health and safety, and quality assurance/quality control (QA/QC) procedures that will be followed
- An estimated schedule for completion of the investigation
- Reporting requirements
- Any permits or regulatory requirements necessary for completion of fieldwork

The Draft Work Plan will be provided to the EPA and the State for approval.

The additional investigation will be initiated and implemented in conjunction with the routine or enhanced monitoring activities required under the RMP. If, as a result of the investigation, modifications to the routine monitoring program are made under Decision 6 of the CP, those modifications will be incorporated into the routine monitoring program as discussed in Section 5 of the RMP.

2.2.5 Decision 3: Has a Hydraulic Gradient Reversal Occurred or Does a Adverse Water Condition Exist in the Yak Tunnel System

Decision 3 evaluates whether a reversal of hydraulic gradient away from the Yak Tunnel has occurred, or an adverse water condition exists, and whether the reversal or adverse condition is caused by conditions within the Yak Tunnel Hydrologic System, or is caused by unrelated natural conditions (e.g., anomalous regional water levels associated with unusually high or low annual precipitation). A reversal in hydraulic gradient can be identified by a change in the direction of the hydraulic gradient between a piezometer (BBW-5 and BBW-8) and the nearest outlying monitoring well (BBW-1, BBW-2, BBW-3, BBW-4 and BBW-10). Note that water levels in BBW-7 provide information regarding the extent to which the Iron/Mikado/Emmett fault complex inhibits westward groundwater flow at the Yak Tunnel. However, these data are not considered suitable for determining a hydraulic gradient reversal because water levels in BBW-7 are naturally lower than water levels in the Yak Tunnel Hydrologic System. The term adverse water condition means those hydrologic, flow and water quality conditions associated with the Yak Tunnel Hydrologic System identified in Table 1. The presence of one or more of these conditions indicates that the response to Decision 3 is YES and the need for response action should be considered in Decisions 4A or 4B. If none of the conditions listed in Table 1 exist, the program returns to routine monitoring and Decisions 1, 2, and 6 are considered.

Decision 3 will be made in conjunction with the EPA and the State after sufficient information has been collected to perform an analysis of site conditions for adequate evaluation of the decision. If the operator determines that the answer to Decision 3 is YES, EPA and the State will be notified of the decision in writing within ten working days. If there is insufficient information available to determine whether a gradient reversal or adverse water condition has occurred, then a NO response will normally be made to Decision 3.

2.2.6 Decision 4A: Is Immediate Response Action Required?

Decision 4A evaluates whether an immediate response action is required to address a reversal of hydraulic gradient away from the Yak Tunnel or an adverse water condition, due to Conditions 1 and 9 (concurrently), 5 or 8 as identified in Table 1. These conditions represent a potential adverse impact that would require immediate response action. Immediate response actions could result in either short-term or long-term response measures.

The following conditions or combinations of conditions represent circumstances that would require immediate response action. Immediate response actions are discussed further in Section 3.

Conditions Requiring Immediate Response Action

- Condition 5: Indicates possible discharge of Yak Tunnel water through a new seep or spring that discharges into a stream or surface water body.
- Condition 8: Indicates that bulkhead intakes are buried or a flow-through pipe in the bulkhead is plugged and normal O&M clearing procedures have proved to be ineffective.
- Conditions 1 and 9: Indicate a gradient reversal, the migration of Yak Tunnel water away from the tunnel, and a potential threat to a public water supply or the environment.

Decision 4A will be made in conjunction with EPA and the State based on all information available at that time. A YES response to Decision 4A initiates Task D activities during which an appropriate response action is implemented.

2.2.7 Decision 4B: Is Non-Immediate Response Action Required?

Decision 4B evaluates whether a non-immediate response action is required to address a reversal of hydraulic gradient away from the Yak Tunnel or an adverse water condition, as identified in Table 1. Non-immediate response actions could result in either short-term or long-term response measures.

The following conditions or combinations of conditions represent circumstances that would require non-immediate response action. Non-immediate response actions are discussed further in Section 3.

<u>Conditions Requiring Non-Immediate Response Action</u>

- Conditions 1, 3, 4, or 7: Indicate a gradient reversal and possible migration of Yak Tunnel water away from the tunnel.
- Conditions 2, 3, or 6: Indicate an unexpected build up of water within the Yak Tunnel Hydrologic System.

Decision 4B will be made in conjunction with the EPA and the State based on all information available at that time. A YES response to Decision 4B initiates Task E activities during which an appropriate response action is developed and implemented. If there is insufficient information available to determine whether gradient reversal or adverse water conditions require a response action, then a NO response will normally be made to Decision 4B. Routine monitoring will continue and the data will be evaluated to determine if enhanced monitoring, additional investigations, or revision of the routine monitoring plan is required.

2.2.8 Decision 6: Does Routine Monitoring Plan Require Revision?

Decision 6 considers whether or not the RMP requires revision. As knowledge of the Yak Tunnel Hydrologic System improves during the course of routine monitoring, it is expected that various elements of the RMP will need to be modified or updated. Modifications to the RMP may include changes in the locations being monitored, the parameters being analyzed, the frequency or location of monitoring, or the methods of analysis applied during data evaluation.

If a decision is made to modify the RMP (Answer to Decision 6 is YES), then appropriate revisions and modifications will be made under Task F. These revisions will be submitted to the agencies for approval prior to being implemented. If no revisions of the RMP are required (Answer to Decision 6 is NO), then routine monitoring will continue with Task A.

2.2.9 Task F: Systematic Revision of Routine Monitoring Plan

In order to ensure that routine monitoring activities or response actions are consistent with the objectives of the CP, a mechanism for systematic revision of the monitoring program has been incorporated into Section 5of the RMP. Revisions will be implemented in response to the routine evaluation of monitoring data or as a result of the implementation of enhanced monitoring, additional investigations, or response actions, where appropriate. Revisions to the RMP will be made with the approval of EPA and the State, and approved modifications will be documented in the Annual Monitoring Report, as provided by Section 6.0 of the RMP, or other documents, as appropriate. Modifications to the RMP may include:

- Incorporation of enhanced monitoring elements (e.g., increased monitoring frequency or expanded target analyte list for water quality analysis)
- Incorporation of additional investigations (e.g., installation of new monitoring wells or piezometers)
- Reduction of monitoring frequency (e.g., less frequent collection of monitoring data or deletion of analytes required for water quality analysis)
- Elimination of ineffective monitoring points

3.0 RESPONSE ACTION MODE OF OPERATION

3.1 Task D: Implement, Evaluate, and Report on Immediate Response Actions

The work performed under Task D consists of two types of activities: (1) implementation and evaluation of response actions applicable in situations where an immediate response action is needed; and (2) evaluation and reporting of the outcome of response actions that have been completed.

3.1.1 Conditions That Warrant Immediate Response Action

The following three conditions warrant immediate response action.:

- Conditions 5 - Occurrence of a new seep or spring discharging to a stream or surface water body resulting from a change in the Yak Tunnel Hydrologic System with water quality that exceeds the Yak Tunnel WTP effluent limitations defined in the Work Plan

- Condition 8 - Catastrophic plugging of the bulkhead intakes or pipes in which repeated O&M clearing procedures fail to restore flow

- Conditions 1 and 9 - Simultaneous reversal of hydraulic gradient and presence of Yak Tunnel water in the vicinity of a public water supply or discharge of untreated Yak Tunnel water to a surface water body or stream

The immediate response actions that may be required in each of these situations are described below. These actions will only be undertaken if the response to Decision 4A as discussed in Section 2.2.6 is a YES.

3.1.1.1 Response Action for Occurrence of Condition 5

The immediate response action to Condition 5 will be to contain and prevent the discharge of a new seep or spring water to a surface water body or stream. The factors that will be taken into account for designing the components of this response action are seep/spring location, flow rate, and the time of year that response is required. If the new seep or spring occurs in a remote location during the summer, it may be readily accessible for implementation of water containment and collection measures even if a new roadway is needed to provide access to that location. In addition, construction of water containment or collection structures could proceed relatively quickly during warm weather.

Logistical difficulties associated with the cold weather might make it impossible to implement response measures at the seep/spring location until the spring melt occurs. In the event that immediate response action is necessary despite adverse winter weather conditions, containment of seep/spring water may have to be restricted to the point of discharge in an adjacent stream that is accessible. The containment would then be moved to the source of the seep or spring when weather conditions permit.

When Condition 5 is encountered the following actions will occur:

- The EPA and the State will be notified, both verbally and in writing, of a YES response to Decision 4A based on the occurrence of Condition 5, and that response action is being undertaken. Resources necessary to carry out response actions will be mobilized.

- After notification and approval of EPA and the State, immediate response actions will be implemented to contain and prevent the discharge of contaminated seep or spring water to a surface water body or stream. The response action would be dependent on site-specific conditions (location, flow rate, time of year, etc.). Examples of immediate response actions could include the following types of activities:

    - Construction of an earthen containment berm

    - Placement of storage tank, construction of holding pond, or enlargement of capacity of bermed area

    - Use of tanker truck or pipeline, to transfer or convey discharge water from storage devices to the treatment plant.

- Preparation of a Draft Additional Investigation Work Plan under Task C of the CP. The purpose of the additional investigation will be to determine the cause of the seep or spring, whether it is permanent or ephemeral, and to evaluate whether long-term actions are necessary and should be taken to eliminate the occurrence of the seep/spring or to design a permanent control/treatment system for its discharge.

- EPA and the State will review and comment on the Draft Additional Investigation Work Plan.

- Preparation of a Final Additional Investigation Work Plan incorporating EPA and the State's comments and submittal to the EPA and the State for approval.

- Upon approval of the Final Additional Investigation Work Plan, the additional investigation will proceed according to the schedule presented in the Final Additional Investigation Work Plan.

- Evaluation of the likely causes for the occurrence of the seep/spring and develop recommendations for additional action, if necessary, upon completion of the Final Additional Investigation Work Plan.

- The EPA will evaluate these recommendations and decide on the appropriate action. If additional action is required, a Response Action Plan (RAP) (see Section 3.1.2) describing the action to be taken and defining the schedule for its implementation will be prepared.

- When the EPA has determined that the response action for the seep or spring has been completed, appropriate changes will be made to the RMP and Work Plan to incorporate additional monitoring or O&M specifications required by the action.

- Upon EPA approval of these revisions, the current response action will be closed out and routine monitoring will resume.

3.1.1.2 Response Action for Occurrence of Condition 8

Condition 8 occurs when normal operation of the Yak Tunnel bulkhead is prevented due to catastrophic blockage of the bulkhead or tunnel immediately behind the bulkhead and application of normal O&M clearing methods fail to remove the blockage. The primary causes for this condition are likely to be: (1) inundation of the bulkhead intakes by rubble transported during a sudden water surge; or (2) plugging of the bulkhead by rockfall from collapse of the tunnel above the intake structure. In this case, the Decision 4A result will be a YES. Prior to the initiation of response action, it is assumed that O&M procedures appropriate for clearance of the bulkhead have been carried out with no success, indicating that other measures are required to restore flow through the bulkhead. If this is the case, access to the upstream side of the bulkhead via the manway is likely to be restricted, and efforts to reestablish flow must be made either from the downstream face or the ground surface.

When Condition 8 is encountered, the following actions will occur:

- The EPA and the State will be notified in writing that Condition 8 exists, appropriate O&M measures have been unsuccessful in reestablishing flow through the bulkhead, that Decision 4A results in a YES decision, and that a response action is being undertaken. Resources necessary to carry out response actions will be initiated.

- After notification and approval of EPA and the State, response actions will occur to relieve the buildup of water behind the bulkhead and to clear blockage on the upstream side of the bulkhead. The response action would be based on site-specific conditions. Examples of these response actions could include the following types of activities:

- Blow out debris with air or water through pipes.
- Drill through existing pipes and inlet screens to open intake pathway.
- Install a well at a suitable location and pump Yak Tunnel water to relieve pressure and prevent backup behind the blockage. Convey pumped water to treatment plant.
- Construct a horizontal drain at a suitable location to allow gravity drainage of Yak Tunnel water from behind the blockage to the treatment plant.

- When the bulkhead has been restored to normal operations, as determined by the EPA in Decision 5, the RMP and Work Plan for OU1 will be revised to incorporate additions or changes caused by the response action.
- Upon EPA approval of the revisions, the revised RMP and OU1 Work Plan will be implemented and the response action will be closed out.

3.1.1.3 Response Action for Occurrence of Conditions 1 and 9

When Conditions 1 and 9 occur concurrently, there is reason to suspect that Yak Tunnel water may threaten a public water supply or the environment. The response action presented below is only appropriate if: (1) a YES decision has been reached for Decision 4A; (2) it has been demonstrated that degradation of surface and ground water quality is due to mine drainage away from the Yak Tunnel; and (3) the observed water quality presents an immediate threat to the water supply or the environment.

Response Action Specifications

The response action presented below is directed toward protection of a public water supply that has been threatened or impacted by migration of Yak Tunnel waters. An alternative water supply on a temporary basis may be required while investigation, design and construction activities are being conducted. When Condition 1 and 9 occur concurrently and the observed water quality impacts present an immediate threat to a public water supply, the following actions, based on site-specific conditions, will occur:

- After it has been determined that the response to Decision 4A is YES, the EPA and the State and parties responsible for management of the affected public water supply will be notified that the response action is being undertaken. If the management of the public water supply disagrees with the proposed action, the matter will be resolved by the EPA.

- If it is deemed necessary, an alternative supply of raw water to the public water treatment system or alternate supply of drinking water will be provided to the affected population.

- If needed to determine appropriate response actions to address the hydraulic gradient reversal, a Draft Additional Investigation Work Plan under Task C will be prepared describing any additional work that may be required to evaluate hydrogeologic conditions, risks to human health, and other information associated with the design and construction of a long-term remedy to the situation. The alternative drinking water supply will be provided until it is no longer needed.

- The EPA and the State will review and comment on the Draft Additional Investigation Work Plan.

- The Final Additional Investigation Work Plan will be prepared and submitted to the EPA and the State after receipt of comments on the Draft Work Plan.

- Upon EPA and State approval, the Final Work Plan will be implemented according to the approved schedule provided in the document.

- If the results of the Additional Investigation indicate that a response action is appropriate, a Draft RAP (see Section 3.1.2) will be developed and submitted to EPA and the State for review. The EPA and the State will review and comment on the Draft RAP, and a Final RAP incorporating EPA comments on the Draft RAP will be prepared.

- Upon EPA approval of the Final RAP, the RAP will be implemented according to the approved schedule.

- When the response action has been completed as determined by the EPA and the State, the RMP and Work Plan for OUl will be revised to incorporate additional monitoring and O&M specifications required as a result of the response action.

- Upon receipt of EPA and State approval, the revised RMP and Work Plan will be implemented and the response action will be closed out.

When Conditions 1 and 9 occur concurrently, and the discharge of untreated seep or spring water from the Yak Tunnel to a surface water body or stream presents an immediate threat to the environment the following actions will be undertaken.

- The EPA and the State will be notified, both verbally and in writing, of a YES response to Decision 4A based on the occurrence of Conditions 1 and 9, and that response action is being undertaken. Resources necessary to carry out response actions will be mobilized.

- After notification and approval of EPA and the State, immediate response actions will be implemented to contain and prevent the discharge of contaminated water to a surface water body or stream. The response action would be dependent on site-specific conditions (location, flow rate, time of year, etc.). Examples of immediate response actions could include the following types of activities:

- o Construction of an earthen containment berm
- o Placement of storage tank, construction of holding pond, or enlargement of capacity of bermed area
- o Use of tanker truck or pipeline, to transfer or convey discharge water from storage devices to the treatment plant.

The factors that will be taken into account for designing the components of this response action are discharge location, flow rate, and the time of year that response is required. If the new discharge occurs in a remote location during the summer, it may be readily accessible for implementation of water containment and collection measures even if a new roadway is needed to provide access to that location. In addition, construction of water containment or collection structures could proceed relatively quickly during warm weather.

Logistical difficulties associated with the cold weather might make it impossible to implement response measures at the discharge location until the spring melt occurs. In the event that immediate response action is necessary despite adverse winter weather conditions, containment of discharge water may have to be restricted to the point of discharge in an adjacent stream that is accessible. The containment would then be moved to the source of the discharge when weather conditions permit.

- Preparation of a Draft Additional Investigation Work Plan under Task C of the CP. The purpose of the additional investigation will be to determine the cause of the discharge, whether it is permanent or ephemeral, and to evaluate whether long-term actions are necessary and should be taken to eliminate the occurrence of the discharge or to design a permanent control/treatment system for its discharge.

- EPA and the State will review and comment on the Draft Additional Investigation Work Plan.

- Preparation of a Final Additional Investigation Work Plan incorporating EPA and the State's comments and submittal to the EPA and the State for approval.

- Upon approval of the Final Additional Investigation Work Plan, the additional investigation will proceed according to the schedule presented in the Final Additional Investigation Work Plan.

- Evaluation of the likely causes for the occurrence of the discharge and develop recommendations for additional action, if necessary, upon completion of the Final Additional Investigation Work Plan.

- The EPA will evaluate these recommendations and decide on the appropriate action. If additional action is required, a Response Action Plan (RAP) (see Section 3.1.2) describing the action to be taken and defining the schedule for its implementation will be prepared.

- When the EPA has determined that the response action for the discharge has been completed, appropriate changes will be made to the RMP and Work Plan to incorporate additional monitoring or O&M specifications required by the action.
- Upon EPA approval of these revisions, the current response action will be closed out and routine monitoring will resume.

3.2 Task E: Develop, Select, Implement, Evaluate, and Report on Non-Immediate Response Actions

In Task E of the CP, response action alternatives will be developed, selected, or modified to mitigate specific conditions that may be the cause of gradient reversal or adverse water conditions resulting from a change in the Yak Tunnel Hydrologic System, as presented in Table 1. In order to select the most appropriate response action, it may be necessary to evaluate all changes that have affected the Yak Tunnel Hydrologic System since the adverse impacts were noticed.

The work performed under Task E consists of two types of activities: (1) development or modification of response actions to address conditions that do not require an immediate response action; and (2) evaluation and reporting of the outcome of response actions that have been completed.

3.2.1 Development of Response Actions for Non-Immediate Situations

In Section 2.2.7 of this document, circumstances that may require some form of non-immediate response action were presented with reference to the conditions listed in Table 1. When conditions that do not require immediate action are encountered, or when immediate situations have been mitigated, additional investigations may be needed to clarify or supplement existing monitoring data. After these have been conducted and the results from the investigations confirm that response is required, a RAP will be prepared to develop, select, and implement the appropriate response action.

Development of an Additional Investigation Work Plan

In general, an Additional Investigation Work Plan will be prepared under Task C of the contingency planning process if: (1) additional monitoring data are required to better understand the behavior of the Yak Tunnel Hydrologic System; (2) more information is needed to better define or identify the cause of one of the Table 1 conditions; or (3) additional engineering data are needed to support the development and design of a response action. The additional investigation will be developed, selected, implemented, evaluated and reported through Task C of the CP (Section 2.2.4). The contents of a typical Additional Investigation Work Plan are summarized in Section 2.2.4. The work plan for each additional investigation will be developed to meet the specific objectives of that particular investigation.

Development of a Response Action Plan

Once the nature of the situation to be corrected is understood, a RAP will be developed to select, design and implement a suitable remedy. The RAP will present all pertinent information necessary for development and implementation of the selected remedy. Supporting documents such as the RMP or Work Plan for OU1 may have to be modified or amended to ensure that the RAP can be successfully implemented.

The RAP will contain a concise summary of the relevant background data; the nature of the problem to be resolved; a summary of risk considerations or results from a risk assessment (if one has been performed); a discussion of alternative approaches that can be applied; selection and justification of the selected response action; design and cost of the selected remedy; and a schedule for implementation of the response action. The RAP will also define the criteria that will be used to determine whether the response action is successful. In more complex cases, a separate set of design plans may be required to describe the components of the selected remedy.

The Draft RAP will be prepared and submitted to EPA and the State for review and comment in compliance with the schedule proposed in the RAP or one specified by the EPA. EPA and the State will review and comment, and a Final RAP that incorporates Agency comments on the Draft RAP will be prepared for EPA and the State's approval.

Implementation and Schedule of Response Action

The Final RAP will be implemented as soon as Agency approval has been obtained. Work will proceed according to the approved schedule and progress reports will be prepared as specified in the RAP.

After the remedy has been completed, its effectiveness and performance will be evaluated according to testing measures and criteria specified in the RAP. The results of this evaluation will serve as the primary basis for the determination of whether or not additional response is required in Decision 5 (Section 3.2).

3.2.2 Discussion of Potential Long-Term Response Actions

As described in Section 1.1, pumping of Yak Tunnel blockage water from the Black Cloud Shaft constitutes current conditions for maintaining water levels behind the blockage. In the event a future condition precludes the ability to maintain blockage water levels as defined in the Work Plan by pumping from the Black Cloud Shaft or a future blockage occurs that impedes the gravity flow of water in the Yak Tunnel, evaluation and implementation of future response actions may be required. The response action would be dependent on site-specific conditions (e.g. location of blockage). Examples of response actions that would be evaluated include:

- Pumping of blockage water from another accessible shaft (e.g, Irene Shaft) and conveying the pumped water to the treatment plant. Activities required to begin pumping from the Irene Shaft, or other accessible shaft, include development of electrical infrastructure, installation of new pump or relocation of the existing pump from the Black Cloud, and pipeline installation to convey pumped water to the Yak Tunnel Treatment Plant. The time required to complete these activities and begin pumping is estimated to be less than six months.

- Installation of well(s) behind the blockage and pumping of water from the wells to the treatment plant.

- Construction of a horizontal drain at a suitable location to allow gravity drainage of Yak Tunnel water from behind the blockage to the treatment plant.

- Engineered improvement of the blockage by subsurface grouting through borings or other techniques.

- Installation of a plug(s) or an additional bulkhead.

3.3 Decision 5: Is Additional Response Required?

Decision 5 evaluates whether a response action selected under either Task E or D is effective and whether additional response is required. If it is found that no additional response is needed based on performance standards established for the action in either Task E or D (Answer to Decision 5 is NO), then the contingency planning process will return to the RMM. Performance standards developed under either Task E or D will be considered part of the OU1 Work Plan. If the response action is ineffective and additional response is required (Answer to Decision 5 is YES), the response will be reviewed and additional response actions will be developed, selected, and implemented as necessary. This process will continue until the results are satisfactory. Routine monitoring of unaffected portions of the Yak Tunnel Hydrologic System will continue while response actions are being implemented. Decision 5 is considered to be an iterative step that recycles through Task E until a given set of undesirable conditions is remediated. The contingency planning program returns to routine monitoring at Decision 6 following satisfactory completion of one or more response actions.

3.4 Reporting Requirements

Reports will be submitted to the EPA and State, as prescribed in Section 6.0 of the RMP. Section 6.0 of the RMP outlines the contents and frequency of reports that will be submitted to the agencies as documentation of routine monitoring.

The results of all decisions made during the contingency planning process will be reported to EPA and the State in writing. If the response to these decisions is NO, this fact will be reported to the EPA and the State in the monthly reports that accompany the tri-annual data transmittals and the Annual RMP Summary Report. If the response to Decisions 1, 2 or 3 is YES, the EPA and the State will be notified in writing within ten working days after the decision is made. The evaluation of Decision 4A & B, 5, and 6 will be done in cooperation with the EPA and the State. The results of Decisions 4A & B, 5, and 6 will be recorded in correspondence between the operator, EPA and the State. If EPA disagrees with a decision by the operator, EPA, in consultation with the State, will make the final decision subject to Dispute Resolution as provided in the Consent Decree.

4.0 REFERENCES

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TABLES

Table 1 Conditions That Constitute Gradient Reversal and Adverse Water Conditions-Yak Tunnel Operable Unit

Gradient Reversal Condition	
1.*	**A change in the direction of the hydraulic gradient between piezometers, or between piezometers and wells monitored pursuant to the RMP**
Adverse Water Conditions	
	Sudden change in head behind the Yak Tunnel Bulkhead, water levels behind the Blockage that exceed the performance standards defined in the Work Plan, or exceedence of 10,684' AMSL, where such conditions are unrelated to the operation of the water treatment plant or conveyance system.
3.	**A substantial rise in water levels in piezometers BBW-5 or BBW-8 as discussed in Section 2.3.3.2 of the RMP.**
4.	**The water from the Yak Tunnel during the non-peak season that significantly deviates from the historic range of pH and specific conductance.**
5.*	**The occurrence of a new seep/spring that is discharging to a stream or surface water body and is hydrogeologically connected to the Yak Tunnel where such seep/spring water exceeds the Yak Tunnel Treatment Plant effluent limitations defined in the Work Plan.**
6.	**An unexpected change or lack of change in water levels in piezometers BBW-5, BBW-10, or the Irene Shaft water level that is inconsistent with the Yak Tunnel blockage water level.**
7.	**A significant change in water quality at one or more of the monitoring points identified in the RMP where such change is not known to be caused by natural conditions or events.**
8.*	**Catastrophic plugging of the bulkhead intakes or pipes in which repeated O&M clearing procedures fail to restore flow.**
9.*	**Presence of Yak Tunnel water in the vicinity of a public water supply source or discharge of untreated Yak Tunnel water to a surface water body or stream, except where discharge is authorized by the EPA in consultation with the State.**

* The occurrence of Condition 5, Condition 8, or Conditions 1 and 9 (concurrently) will result in an immediate response action.

FIGURES

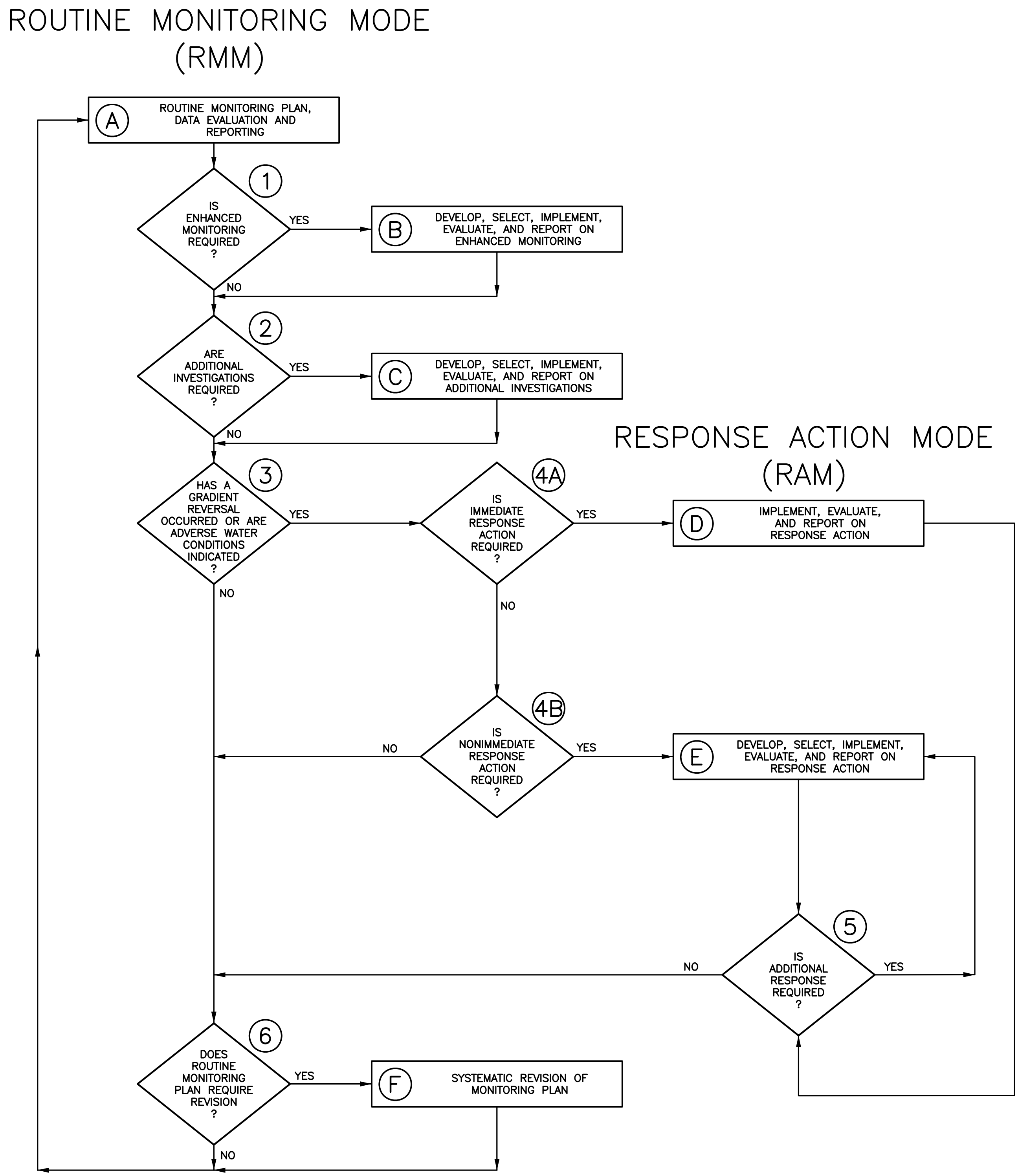

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FIGURE 1
CONTINGENCY PLAN FLOW CHART

Date:	MAY 2008
Project:	180885/37
File:	Figure-01.dwg

APPENDIX A

GLOSSARY

Glossary

Unless otherwise defined below, terms used in this Contingency Plan shall have the meaning assigned to them in the Work Plan.

ADVERSE WATER CONDITIONS. Conditions described in Table 1 of the CP.

BLOCKAGE. An obstruction to groundwater movement in the subsurface due to rockfalls collapse, sedimentation, or plugging of a conduit for water such as a tunnel, drift, stope, winze, or fault. A localized blockage may cause flow in one pathway to be restricted and water to back up until another flow path is encountered.

CONTINGENCY PLAN. The plan that describes options or contingencies that will be undertaken in the event that a predetermined set of undesirable hydrologic conditions occurs. The Contingency Plan for the Yak Tunnel Operable Unit describes the undesirable conditions that will be monitored, the type of monitoring program that is required to detect their occurrence, and the actions that will be taken to control or mitigate these conditions.

HYDRAULIC GRADIENT REVERSAL. A change in groundwater elevations that causes the direction of the hydraulic gradient to reverse away from the Yak Tunnel.

PARAMETER. A monitored attribute of the Yak Tunnel Hydrologic System.

MONITORING POINT. The location at which an indicator or parameter is monitored, such as the location of a given piezometer or seep.

MONITORING WELL. A well designed specifically for the collection of groundwater quality samples. Groundwater elevation measurements can also be made at monitoring wells.

PIEZOMETER. A well designed specifically for measurement of groundwater elevations at a given location and depth. Piezometers are not intended for groundwater quality sampling.

RESPONSE ACTION. An action that can be taken to mitigate or control an undesirable hydrologic condition such as a gradient reversal away from the Yak Tunnel or the occurrence of a new seep or spring that discharges low quality water into a surface water body. Response actions will be selected from a range of potentially applicable actions and will be developed or modified to meet site-specific conditions and response goals. The effectiveness of a given response action will be evaluated using criteria developed specifically for each action.

ROUTINE MONITORING. The Routine Monitoring Mode of Operation of the Contingency Plan during which the Routine Monitoring Plan is implemented.

ROUTINE MONITORING PLAN. The plan that describes the objectives, monitoring points, indicators, indicator thresholds, sampling and laboratory methods, quality assurance procedures, data evaluation methods, and reporting requirements that will be implemented during the baseline and routine monitoring programs.

YAK TUNNEL HYDROLOGIC SYSTEM. The subsurface flow system that consists of the entire length of the Yak Tunnel and groundwater which flows to or from the Yak Tunnel.